Disney

4A

SCIENCE in COMICS

Life in the Seas

THE ABC'S OF THE OCEAN

Disney COMICS

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SCIENCE in COMICS

Life in the Seas

SAVING THE GREAT BARRIER REEF

Disney **Science in Comics** is a series of comics titles designed to build a sound knowledge base for kids 8–12 years old, on science themes related to features and secrets of the world around us.

LIFE IN THE SEAS: *SAVING THE GREAT BARRIER REEF*

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Contents

Meet Nemo and his friends..... 4

UNIT 1 – THE ABC'S OF THE OCEAN

AN EXCITING START! 7

The Secrets of The Sea

- The marine world 17
- Living in the depths..... 18
- Luminous creatures 19
- A breathing ocean..... 20

FIRST EXPLORATIONS..... 21

The Oceans and the Climate

- What is the climate?..... 31
- It's too hot!..... 32
- Ocean currents 33
- Highways of water 34

SURPRISING STOPS 35

Diversity Is Richness!

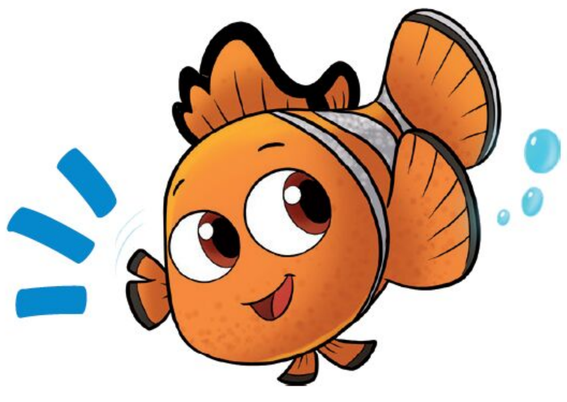
- A variety of colors..... 45
- A temperature for everyone 46
- The power of diversity 47
- An ocean to save 48

A COLORLESS PROBLEM 49

Delicate Balance

- Ocean acidification..... 59
- A threat to the sea 60
- The world of corals 61
- Look out for changes..... 62

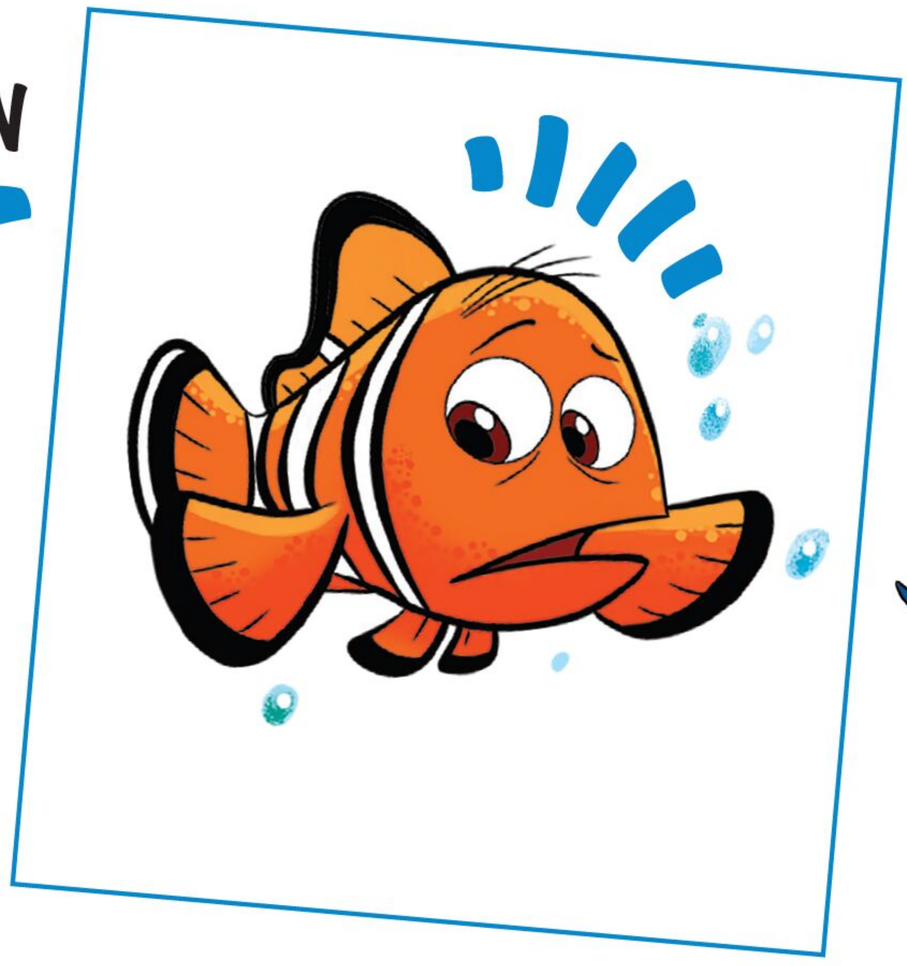
Meet Nemo and his friends



NEMO

Despite being born with **one smaller fin**, Nemo **can do anything** other fish can do. Thanks to his **trusting nature** and his **love for the sea**, he always brings out the best in everyone he meets, and his enthusiasm is contageous. Once he learns about the problems affecting the oceans, he's determined to find out **how to fix them**, whatever it takes.

MARLIN

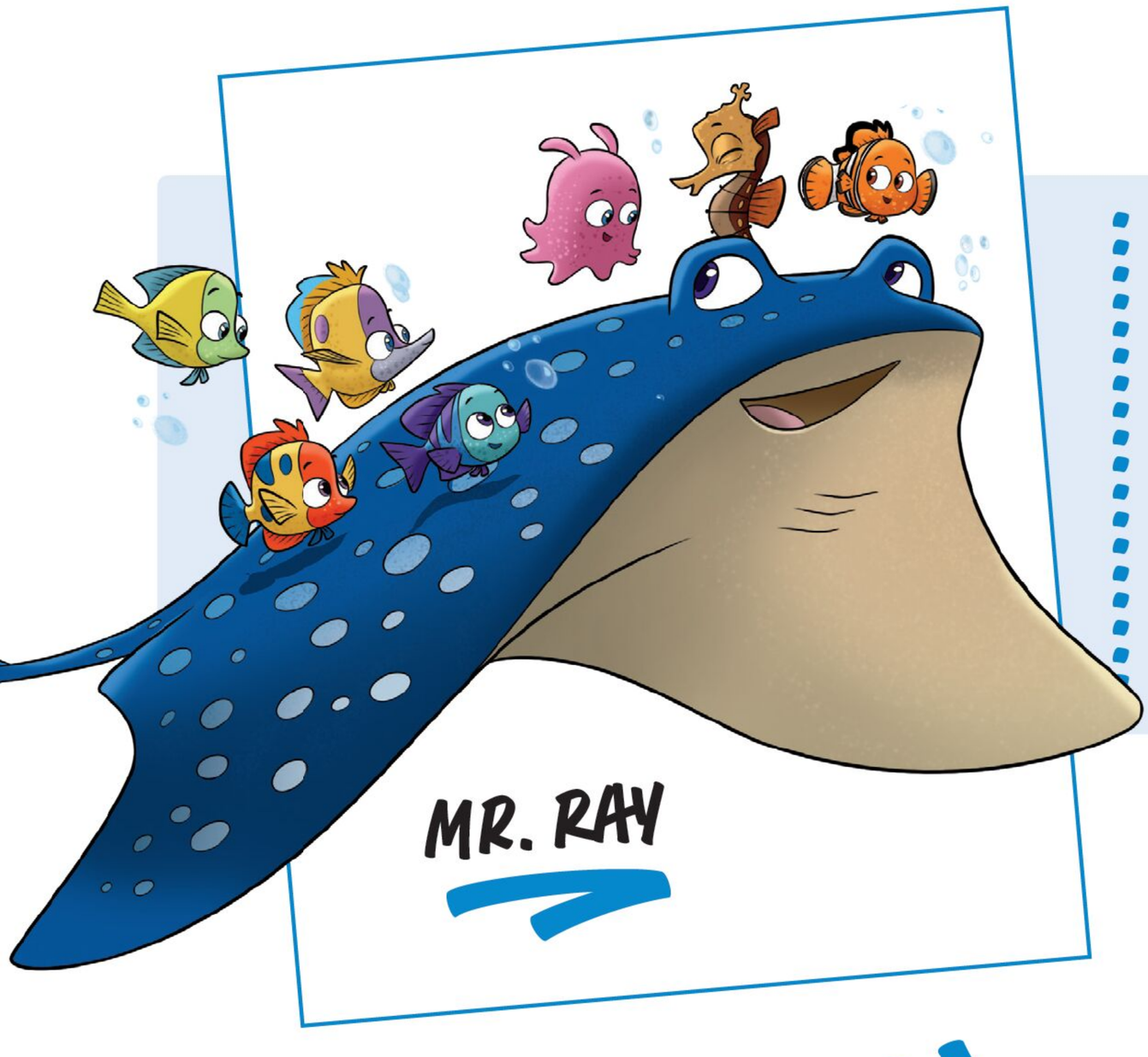


He's one of the biggest worriers and the most **overprotective** parent in the whole ocean. He would do anything to **protect** his son and can't stop giving out **safety tips**. Luckily, he has learned to **trust** Nemo and will follow him on even the most unpredictable adventures.

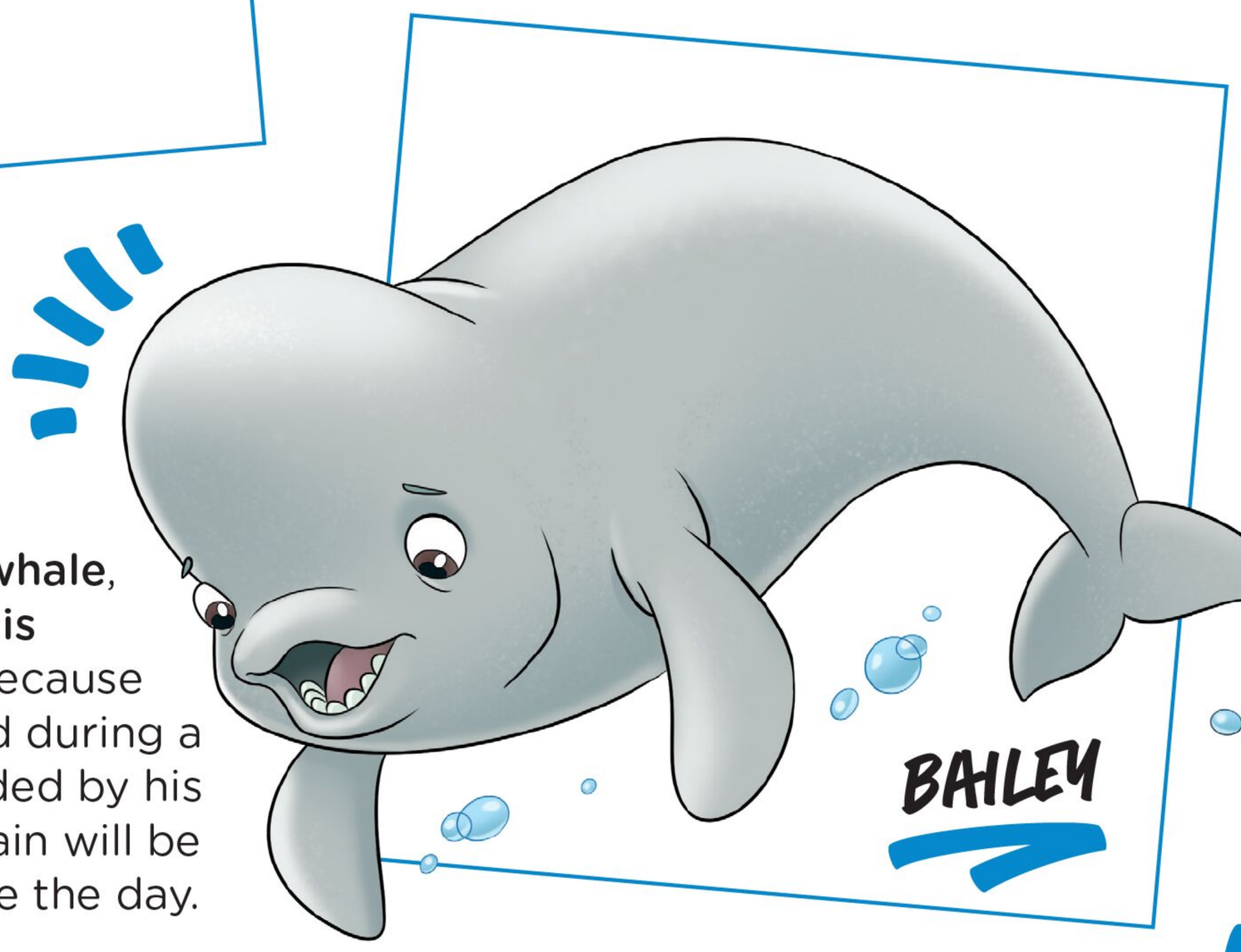
DORY

A regal blue tang fish who suffers from **short-term memory loss**, Dory **has a big heart** and always **looks on the bright side** of things. Her **sunny** personality makes her a great **friend**, and she's always ready to join in. **She can read the human language**, and when faced with the unknown, she always repeats her motto: "Just keep swimming."

Hank is an **octopus**, but he calls himself a **septopus** because he lost a tentacle somewhere along the way. His **camouflaging skills** help him in many situations, and despite his grumpy personality, he would do anything to help his friends.
His time at the Marine Life Institute will prove very useful during his new adventure across the ocean.



Nemo's **science and marine education teacher** is an **enthusiastic stingray**. He loves to take his little fishy pupils for a ride on his back to **show them the other creatures on the seabed**, while singing his special memory-aiding songs to help them learn a whole bunch of interesting facts.



Bailey is a rescued **beluga whale**, but he **sometimes doubts his echolocation capabilities** because he thinks they got damaged during a previous accident. Surrounded by his friends in need, he once again will be able to use his talent to save the day.

AN EXCITING START!

Mr. Ray is finally back from migration, and today he's taking the class on a fantastic trip.

Hello, class! Are you ready to go?

I'm super ready!

Nemo, wait!

Yeees!

Remember, the ocean isn't safe. You need to be careful, and...

C'mon, Marlin! It's only a trip to the Great Barrier Reef.

SWOOOSH

Have fun, Nemo!

Thanks, Dory! Bye, Dad!

Climb aboard, explorers! Optical orbits up front!

Let's go!

Exploring the ocean is oh so lyrical when you think thoughts that are so empirical!

Oh, I didn't know they were coming, too!

Gasp!

Dad! Dory! Are you following us?

Didn't we tell you? We're your chaperones!

Oh, yes, we are!

We're going to help Mr. Ray look after you!

Really? That's exciting!

Let's see... who remembers the name of this place?

It's the **Drop-Off!**

Drop-Off?! What? Maybe this is too dangerous for the kids?

Don't worry, Marlin! We're gonna look after them!

Oookay, but we **won't** let them swim in the open ocean!

So who knows which zone we're in now?

Drop-off zone!

No, it's the open-sea zone!

Good guess. I'll give you a clue. Seaweed can't live in the deepest parts of this zone, because there isn't enough sunlight and it can't perform **photosynthesis**!

Photo... what?

Photosynthesis! It happens when seaweed captures energy from sunlight to produce its food.

This process also produces **oxygen**, which is very important for life!

POFF!

"Heh heh. Good job, Nemo. The PELAGIC zone is the water away from the shores. It's divided into **five subzones**, each at different depths."

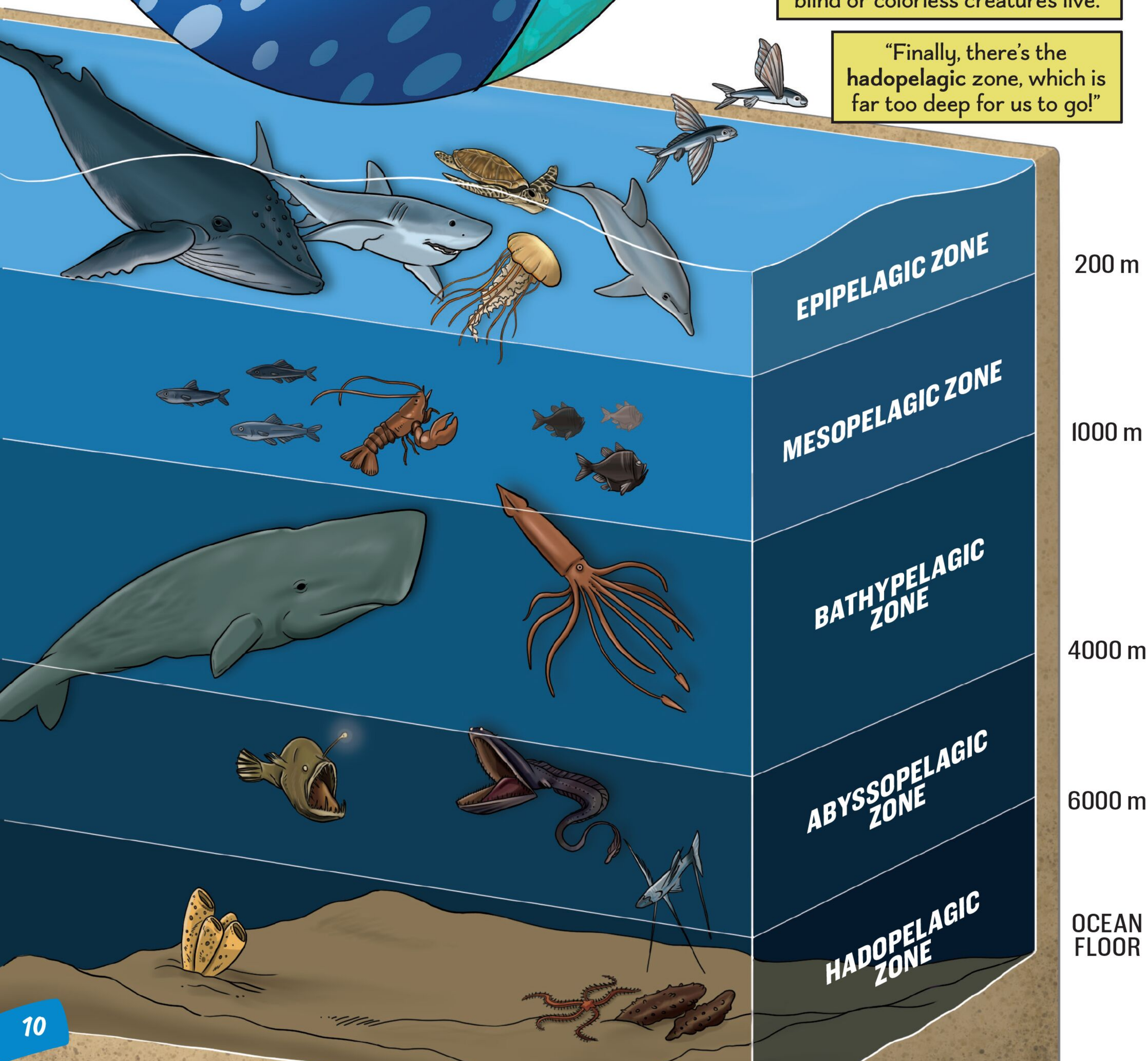
"The **epipelagic** is the only pelagic layer that sunlight can properly reach."

"Then there's the **mesopelagic**. Here, some light reaches the water, but not enough for photosynthesis."

"In the **bathypelagic** zone, the ocean is almost dark. There are no living plants here!"

"The **abyssopelagic** zone is completely dark, and it's where blind or colorless creatures live."

"Finally, there's the **hadopelagic** zone, which is far too deep for us to go!"



Wow!

Can we see the **bysso-abyss**-- um... the **abyssopelagic** zone?

No, I don't wanna lose my colors!

Atchooo! Just talking about water makes me sneeze!

Yeah, let's visit all the **pelagic** zones. I'll lead the way!

No, no, no... forget it, Dory!

Huh? Oh well, looks like I already forgot!

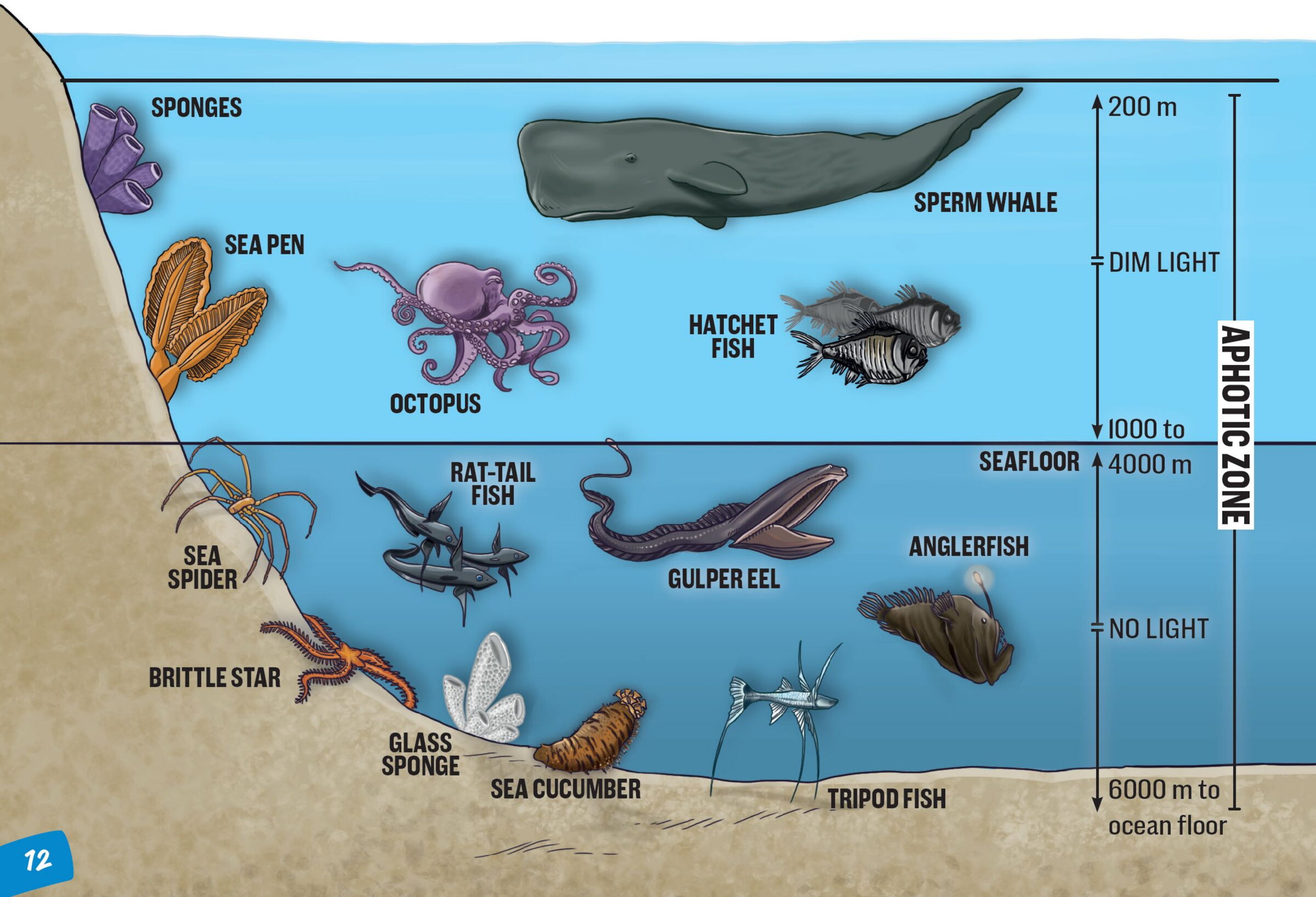
What is the **aphotic zone**, Mr. Ray? We talked about it before you left for migration...

Good question, Nemo!

Aphotic means "**without light**." It's the area of an ocean where there's very little or no sunlight at all!

And the deeper you go, the more dangerous it gets! Remember that anglerfish?

"The aphotic zone starts around 200 meters below the ocean surface and ends at the ocean floor. This dark area, which includes all the zones we mentioned earlier except for the epipelagic, is the largest part of the ocean and is home to many marine creatures."



Whoa! The creatures of the aphotic zone are so cool!

You're right, Pearl!

Uh?

Where's Dory?

I don't know. She was here a second ago...

I saw her swimming toward... the deep waters!

Deep waters?! Surely we can't go looking for her with the kids.

Of course we can! Climb aboard! Let's go and see!

The group swims a bit deeper and...

What do you usually eat for breakfast?

Dory?!

Why is she having breakfast now?

Dory, what have you gotten yourself into now?!

Wow! That's **huge!**

Oh, hello, this is my new friend. His name is... is...

Look, class! That's a giant... **giant squid!**

Don't move or he'll see us. Dory, be careful!

What's your name again, dear?

Hey! What's happening?

Dory! Swim!

SWOOOSH

Heeelp!

As you see, some deep-sea creatures grow much bigger than creatures in the shallow waters.

Why?

It could be because of the **low temperatures** in this zone.

So... if I'm cold, I might become a **giant flapjack octopus!**

No way! But I'm sure I'd become a **giant seahorse**, wouldn't I?

!

BONK!

?

Phew, that giant crab saved us!

I don't think so. If you get too big, I won't be able to carry you anymore!

Aw, you're right!

Please, Dory, try not to put the kids in danger again!

Me? Danger? I just saved you from that giant octopus!

Squid!

So... are you ready to keep exploring? The Great Barrier Reef is waiting for us!

Yeahhhh!

I hope the rest of the trip is a little more relaxing.

CONTINUES ON PAGE 21

THE SECRETS OF THE SEA

- The marine world
- Living in the depths
- Luminous creatures
- A breathing ocean

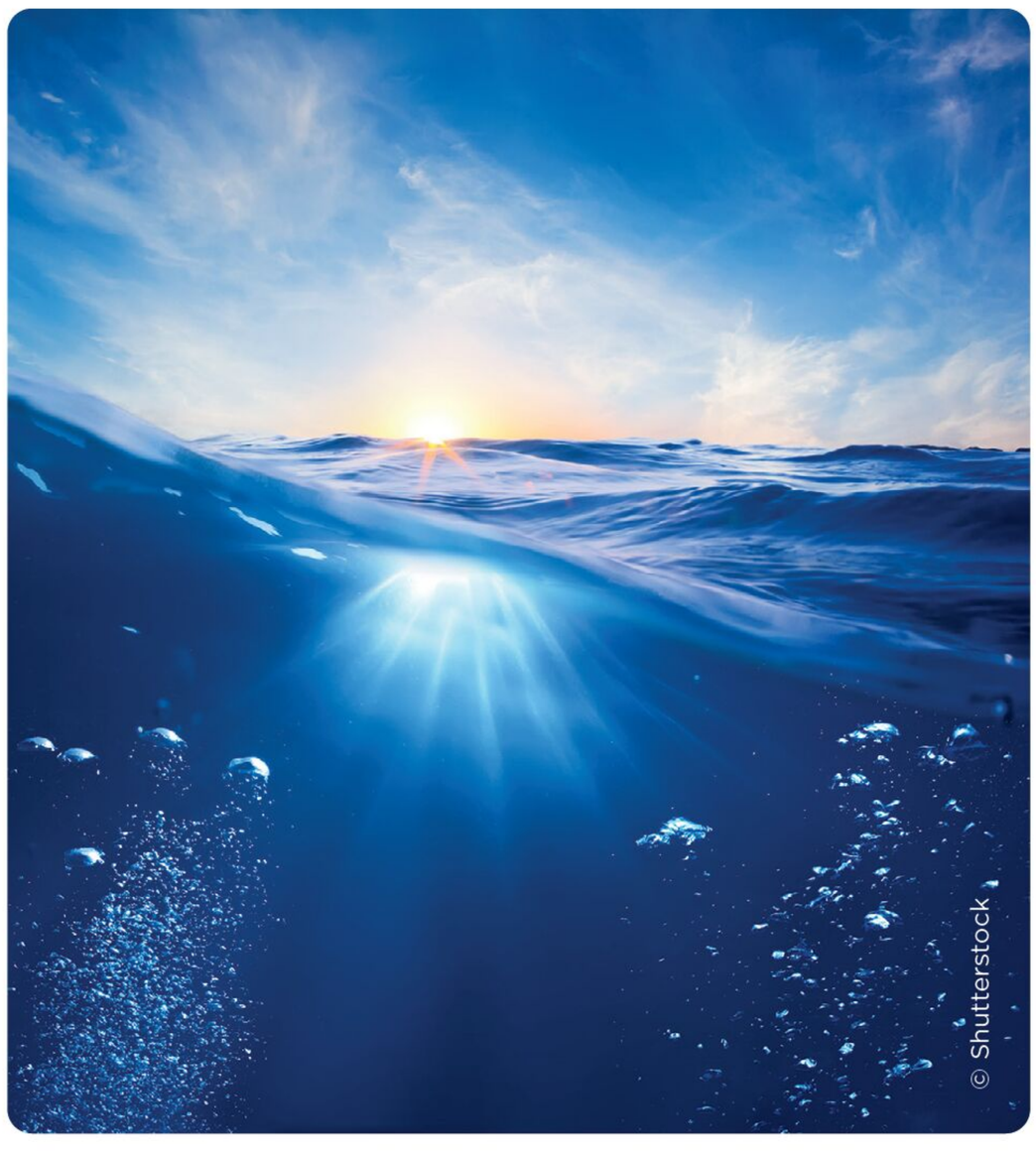
The marine world

LIGHT AND DARKNESS IN THE SEA

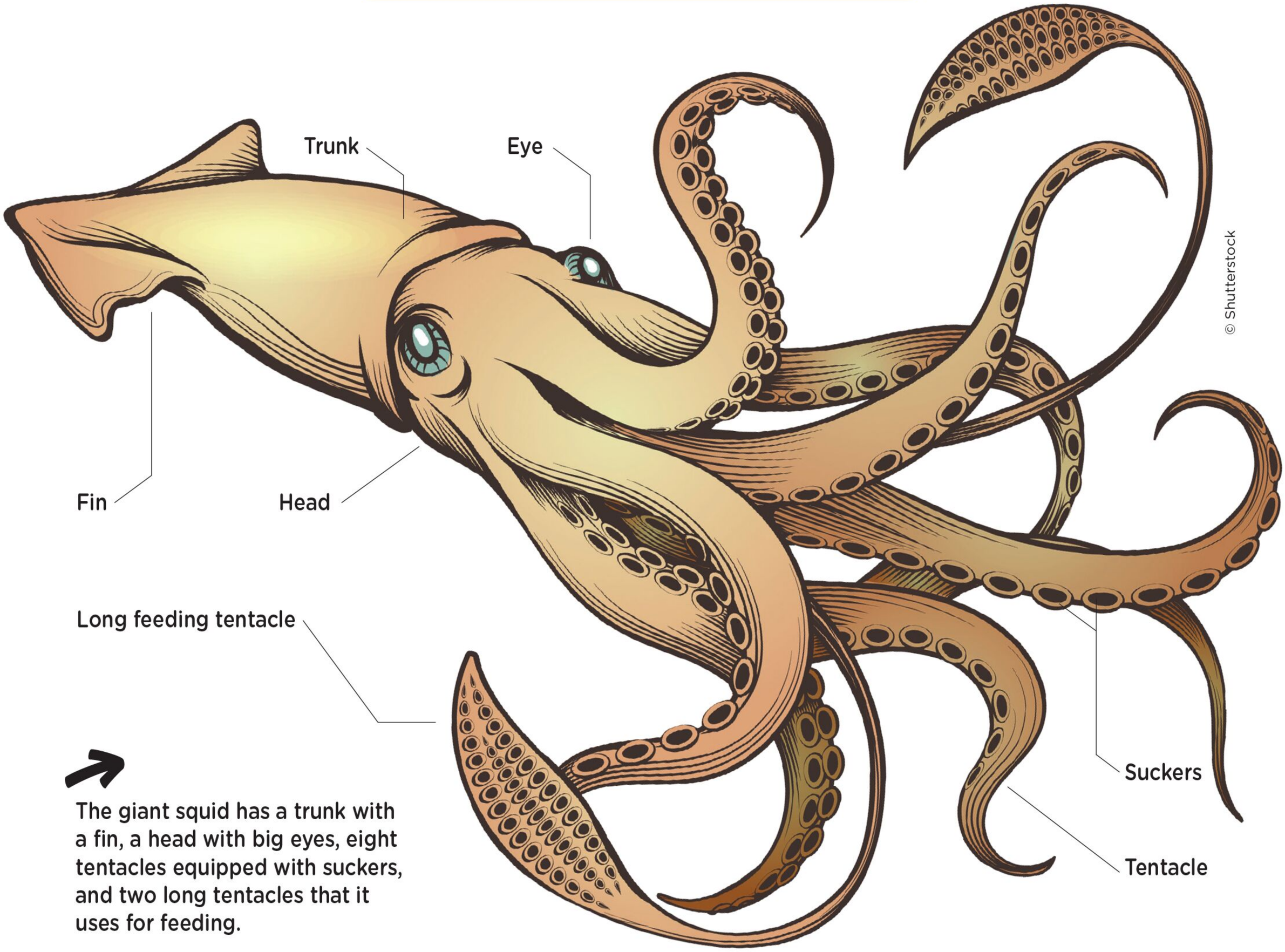
The ocean is populated by surprising creatures and is full of secrets that lurk underwater. Many of them can be discovered when exploring the **pelagic zone**, a place where there's basically only water. The pelagic zone is made up of the **oceanic zone**, which is open sea, far from the coast, rocks, and seabed, and the **neritic zone**, closer to the coast, though it doesn't really reach it.

The ocean can be divided not only by how far from the coast an area is, but also into zones based on depth and the presence of light: the farther you go down, the darker everything becomes, because the sun's rays are unable to penetrate that far. In fact, **light doesn't reach below 150 to 200 meters**. Below this depth starts the area called the **aphotic zone**, which means "devoid of light". The area near the surface, on the other hand, is called the **photic zone**, which means "illuminated" (*fòs* in ancient Greek means "light"). This is where algae and other plant organisms that need light to live are found.

The pelagic zone consists of a column of water starting from the surface and extending into the depths.



Living in the depths



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The giant squid has a trunk with a fin, a head with big eyes, eight tentacles equipped with suckers, and two long tentacles that it uses for feeding.

ADAPTING TO THE DEPTHS

Sea creatures face different challenges depending on the ocean zone in which they live. In the aphotic zone, it is more difficult to find food, so it is home to fewer species than the sunlit photic zone, and its inhabitants have adapted in different ways to survive in difficult conditions. For example, many of them are **omnivores**, meaning they eat any organism they find in the depths. Some are **very small**, while others have large, **extendable mouths** with sharp teeth. Others have **big eyes** to see everything clearly even in the darkness of the ocean depths, so they can both defend themselves and attack better. Like the **giant squid**: its eyes are the largest in the whole animal kingdom; each one is the size of a soccer ball!

Another extraordinary creature is the **Japanese giant spider**, which lives between 50 and 500 meters deep in the Pacific Ocean near Japan. Its rounded shell and long, slender legs make it look like a huge spider, while its large size may help it survive in the cold temperatures of the depths, because it **loses less heat**.

Luminous creatures

TRICKS OF THE LIGHT

The ocean depths hide many other surprises, such as strange, luminous creatures moving around. These animals have special organs in their body that can **produce their own light**. This is called **bioluminiscence**, which, among other functions, helps them to easily blend in with the reflections and shadows of the surrounding environment. Their blue-green light, in fact, is confused with the light filtering through the upper layers of the ocean. This phenomenon is called **counterillumination**. It helps these animals **hunt as well as escape** from predators. Some of these animals may also rely on bioluminescence to communicate, especially when mating.

FLUORESCENCE

There are also other marine creatures capable of glowing in the dark: **corals**. For example, some corals that appear pink in full light, might look green and red when illuminated in dark waters. This happens thanks to **fluorescence**, the ability to capture light of a certain color and emit it in a different color. Scientists are still studying the phenomenon, but the main theory is that these changes in color **protect the zooxanthellae**, the tiny algae that live in corals, from the sun's damaging rays!

Fluorescent corals growing in the sea of the Raja Ampat archipelago, Indonesia.

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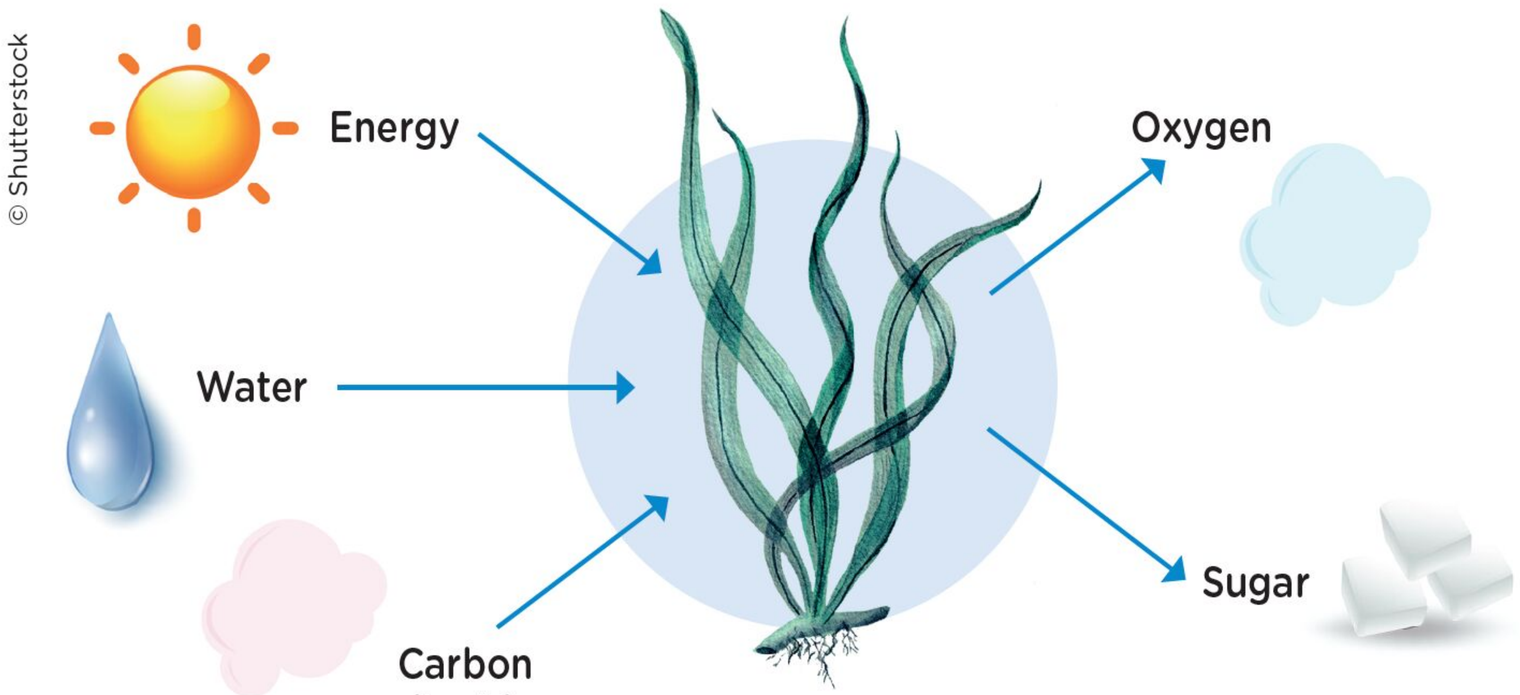
A breathing ocean

AQUATIC PHOTOSYNTHESIS

All living things need energy, which they get specifically from sugars. However, they don't all need to go in search of food: plants, even marine ones, and algae **produce these sugars themselves with help from the sun**. In fact, they are able to absorb sunlight and use its energy to produce them, thanks to a special substance they have, called **clorophyll**. This process is called **photosynthesis** and it's very important for life on Earth because it also **produces oxygen**. In fact, half of the planet's oxygen comes from photosynthesis that takes place in the oceans.



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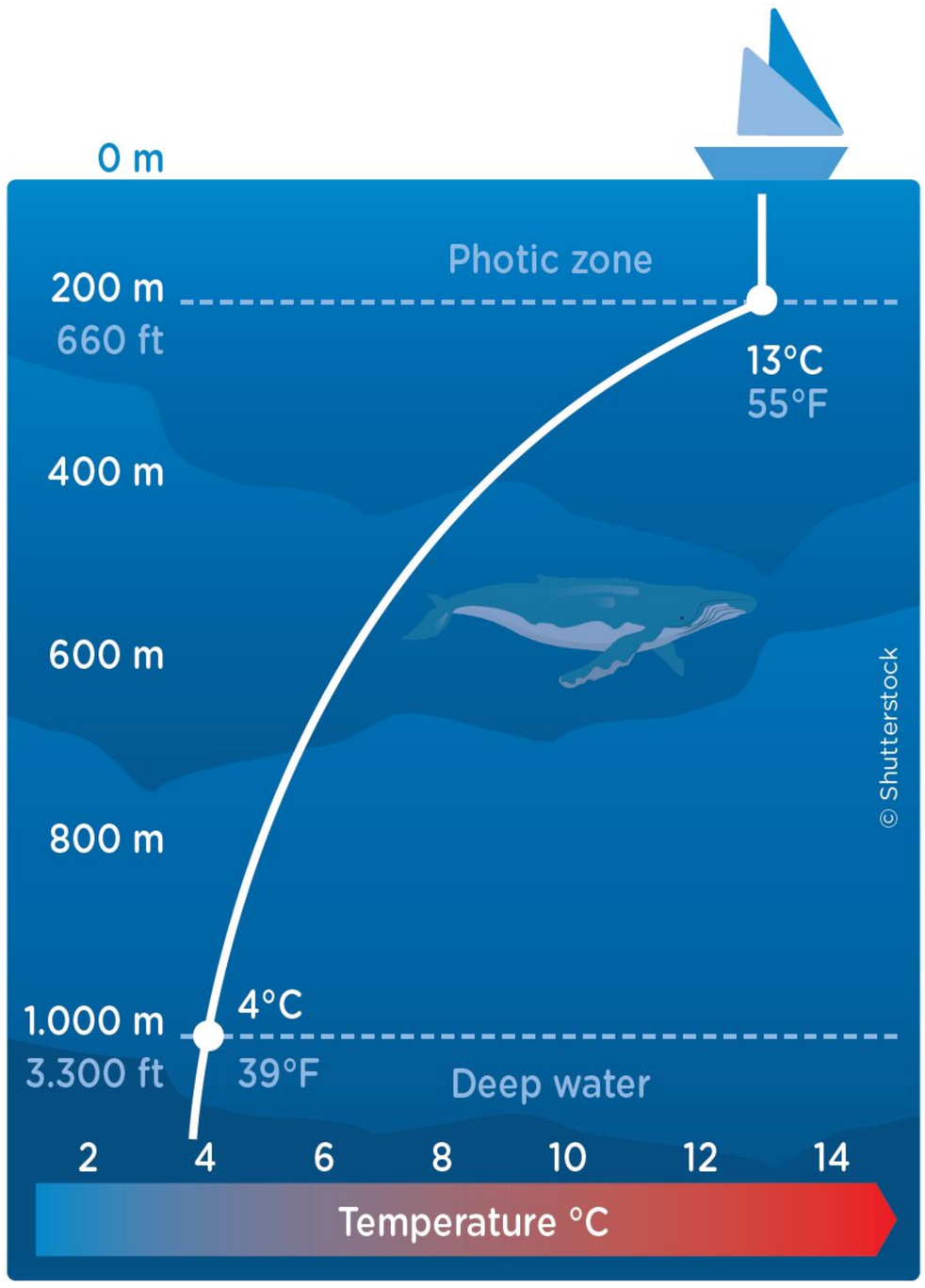
Thanks to the sun's energy, marine plants and algae produce sugars from water and carbon dioxide, a gas that is present in the atmosphere and also found dissolved in water. Oxygen is generated as a "waste" product, which the plant releases, making it available for animals to breathe.

WATER AND TEMPERATURE

In the ocean, **the water doesn't have the same temperature everywhere**: it's warmer on the surface and gets colder the farther it goes down, toward the seabed. Like a cake that may have different layers, the ocean is said to be **layered** in areas with different temperatures. And each marine species does best in a specific temperature: some need to stay cold and can't stand warm waters, while others, such as tropical species, do well only in warm waters.

The average water temperature of the oceans is 13°C. The temperature remains stable in the first 200 meters and then rapidly decreases the deeper you go, reaching 4°C at 1,000 meters deep.



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Yay! Catch me if you can!

You're too slow for me. That'd be too easy!

Be careful, kids!

C'mon, Marlin, they're having fun!

Phew! I need a rest.

Don't worry, we know that seahorses are **not fast** swimmers!

!?

Well, yeah, but we can **wrap our tails** around strands of seaweed!

Whoa! That's even better than swimming fast!

Ah, I heard the word **seaweed**. Do you know why there's so much here?

Because it's a... seaweed forest?

Yes, Tad! But also because we're in the **photic zone**!

The photic zone? Is it different from the **aphotic** one you told us about?

Clever fish!

Of course! *Photic* means "with light"!

Oooh, wow!

And what does **aphotic** mean? I don't remember.

Aphotic means "without light"!

PHOTIC ZONE

200 m

APHOTIC ZONE

The **photic zone** starts at the surface. It reaches down to about 200 meters deep.

The larger species in this area include **blue whales** and **sharks**.

"In the pelagic zone, the shallow waters near the coast are called **neritic waters**!"

"*Neritic* means 'close to the coast'!

NERITIC ZONE

COAST

Up there, along the coast, you can find these big marine organisms called **macroalgae**!

Aren't those just...

Seaweed?

Exactly! *Macro* means "big" and *algae* means "seaweed." They grow so much because they can perform...

Photosynthesis.

Hank?!
You're back!
Gasp!
POFF!
I thought you wanted to take a few days off.
Well, I was on my way but...
You missed us and wanted to come to the Great Barrier Reef, too, didn't you?
Me? No. I was trying to take a vacation away from you, but...
We missed you, too!
Aw, I can feel all your **three hearts*** beating with joy, Hank!
Anyway, I was on my way when I bumped into something strange. Mr. Ray, could you take a look at it?
Of course. What is it?

*Octopuses have three hearts and eight tentacles. Hank has only seven tentacles, so everybody calls him a "septopus," but he's still got three hearts.

It's up here at the surface.

The surface?!

We're coming, too! A school trip within a school trip! Cool!

No, Mr. Ray. It's way too dangerous for the kids up there. I'm sure you don't--

Climb aboard, class! We're going to the surface!

Sigh. Nobody listens to me.

I do! But I just forget what you say!

So...

Traveling through neritic waters is oh so great, especially on a sunny day!

Sunny day!

After a short journey...

Here it is. They're on that rock.

Listen to me, we've still got time to go back toward the Great Barrier Reef!

C'mon, Dad! This is gonna be cool!

Yes, I'm sure Hank knows what he's doing!

C'mon, it's just here at the top of the rock.

Okay... maybe not.

Hey!

Uh, Hank, fish can't climb on rocks.

And neither can flapjack octopuses.

Or seahorses.

Oh, yeah, sorry. Uh, just take a quick look.

Okay, but very quickly, everyone. You know we can only hold our breath for a short time out of the water!

No, I won't swap my beautiful shell for yours. Yours is so thin it's gonna break!

Well, yours is even more fragile. Who said I wanna move there?

Hey, you two. Stop your bickering. Both of your shells are really thin!

What do you know about shells? You don't even have one!

Our shells are fine. Leave us alone!

Well, I tried. Good luck with those thin shells!

SPLASH

What happened to those hermit crabs, Mr. Ray?

Why do their shells look so fragile?

Yeah, I thought shells were really **hard**.

Unfortunately, the ocean is becoming **more acidic** than it used to be.

Yah... ba... ba... ba...

What are you saying, Dory? I can't understand you!

The water doesn't taste sour at all!

What?

Acidic does also mean sour, but not in this case.

Ocean acidification happens when the water absorbs a specific **gas** from the atmosphere.

This gas is called **carbon dioxide**. It makes the water more acidic.

What does acidic water have to do with the shells?

Don't ask me. But I bet Mr. Ray can tell us.

Shells are mainly made of a mineral called **calcium carbonate**. Unfortunately, the acidic water **damages** it.

That's why the shells become thinner and thinner... until they break.

That's terrible! We have to save them, Mr. Ray!

No worries, Nemo. I'm sure we can just **rebuild** the shells.

I'm afraid we can't, Dory!

Maybe one day we'll find a solution.

Yeah, we can think about it while **we** swim to the Great Barrier Reef.

You're coming with us?

That's fantastic!

I'm still going on my vacation. It just happens to be the same way you're going.

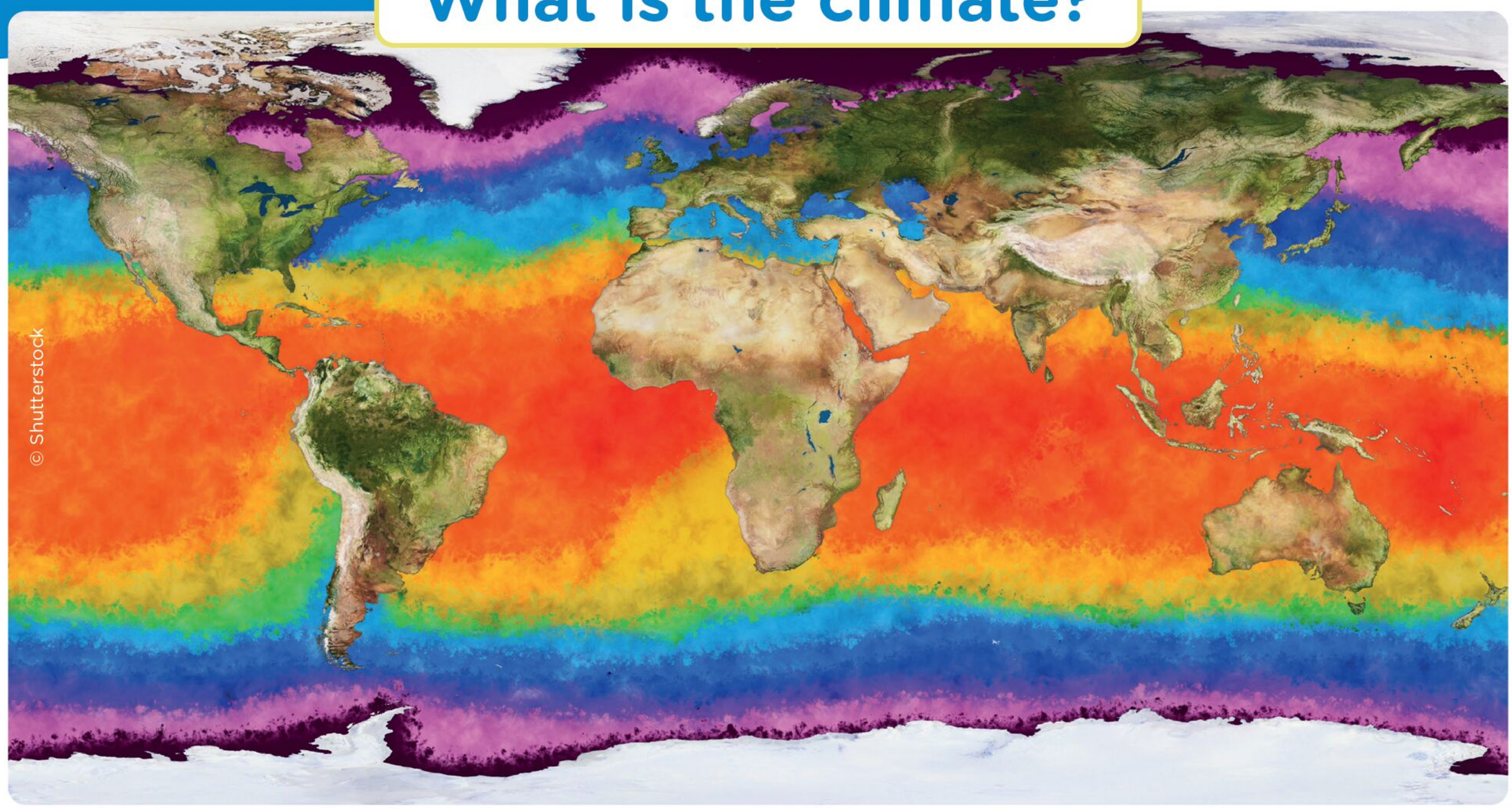
Yay!

CONTINUES ON PAGE 35

THE OCEANS AND THE CLIMATE

- What is the climate?
- It's too hot!
- Ocean currents
- Highways of water

What is the climate?



Sea surface temperature in degrees Celsius

-2 | 2.3 | 6.5 | 10.8 | 15 | 19.3 | 23.6 | 27.8 | 32.1

The colors indicate the average temperatures of the ocean: warmer (red) near the equator and colder (purple) at the poles.

WEATHER AND CLIMATE

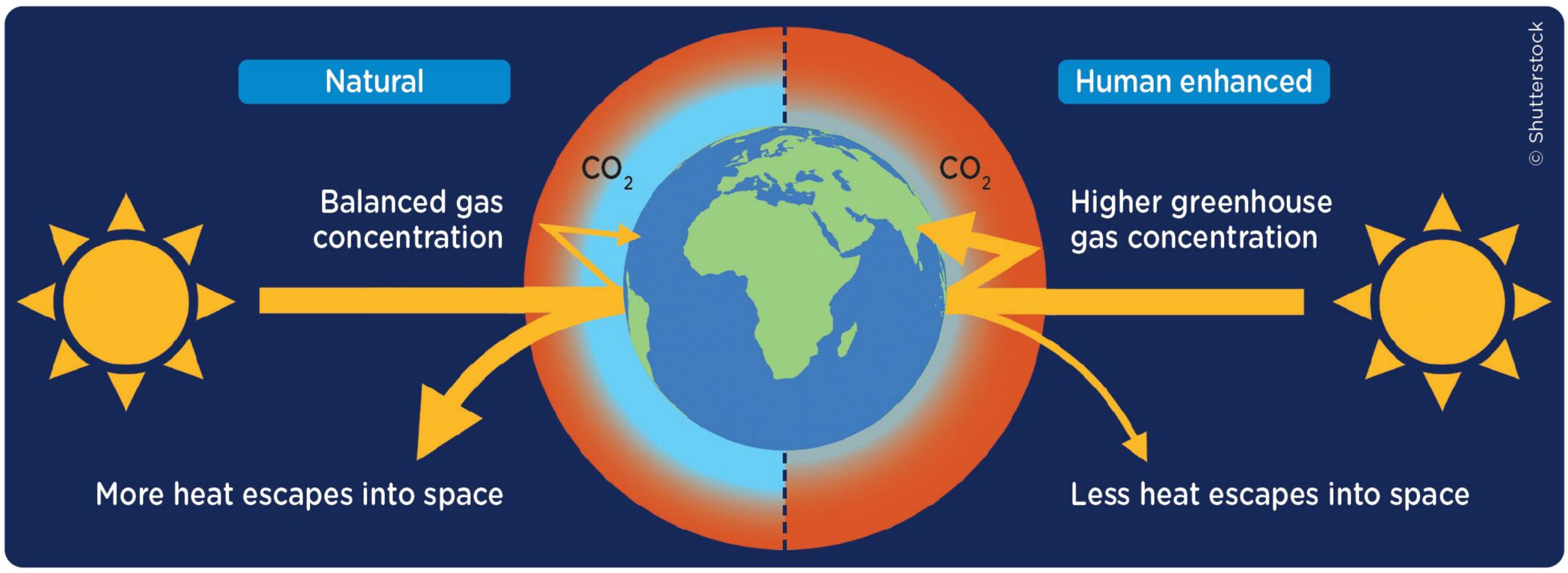
Our planet, and therefore also the ocean, is divided into different climatic zones. **Climate** is the set of atmospheric conditions—for example, temperature and amount of rain—of a specific place **over the years**. However, be careful not to confuse it with **weather**. The latter refers to the atmospheric conditions present in a specific place within a precise, **short span of time**: a few hours or a few days.

Temperature is one of the most important aspects of the climate—there are some very cold places on Earth and other very hot ones—and temperatures are also **regulated by the ocean**, which therefore affects the climate of the whole Earth.

CO_2: WHAT A PROBLEM!

Earth and the ocean aren't two separate worlds. In fact, there are various gases in the marine waters that are also found in Earth's atmosphere, including **carbon dioxide (CO_2)**. The water on the surface of the sea **exchanges these gases with the air** it comes into contact with. In this way, the sea helps keep the gases that make up the air in the right quantities for living organisms. Unfortunately, in recent decades, various human activities have caused CO_2 levels in the atmosphere to rise too quickly to maintain this balance. For example, coal and oil release carbon dioxide when burned to produce energy. And the **extra carbon dioxide** in the atmosphere causes **serious damage** to the planet.

Too much CO_2 in the atmosphere traps the sun's rays; the planet's temperature rises, just like in a large greenhouse.



It's too hot!

AN SOS FROM THE SEA

The amount of CO_2 in the atmosphere is increasing more and more, and faster and faster, meaning the excess in the air can't be absorbed by the ocean. And too much CO_2 retains the sun's rays and their heat. This is why the **planet's climate is getting increasingly warm**, endangering many living beings.

For example, due to sea ice melting, some species of penguins have been forced to migrate closer to the South Pole. And in tropical waters, too high temperatures are causing the **bleaching of coral reefs**! This means they're gradually losing their colors. It's a sign of suffering, and in the end corals can even die.

Bleaching can lead to the death of entire coral reefs, seriously damaging marine life.

CLIMATE REGULATORS

The ocean is very important for the climate because, thanks to its water currents, it can **change the temperature** of many regions of Earth. In fact, water can accumulate and transport large amounts of heat; this is called **heat capacity**. In practice, ocean currents behave like a **giant temperature regulation system**: warm currents move toward cold areas, for example, heating up the poles; meanwhile, cold currents flow in the opposite direction, cooling the equator. This is how the ocean keeps the climate of the entire planet balanced.

Ocean currents

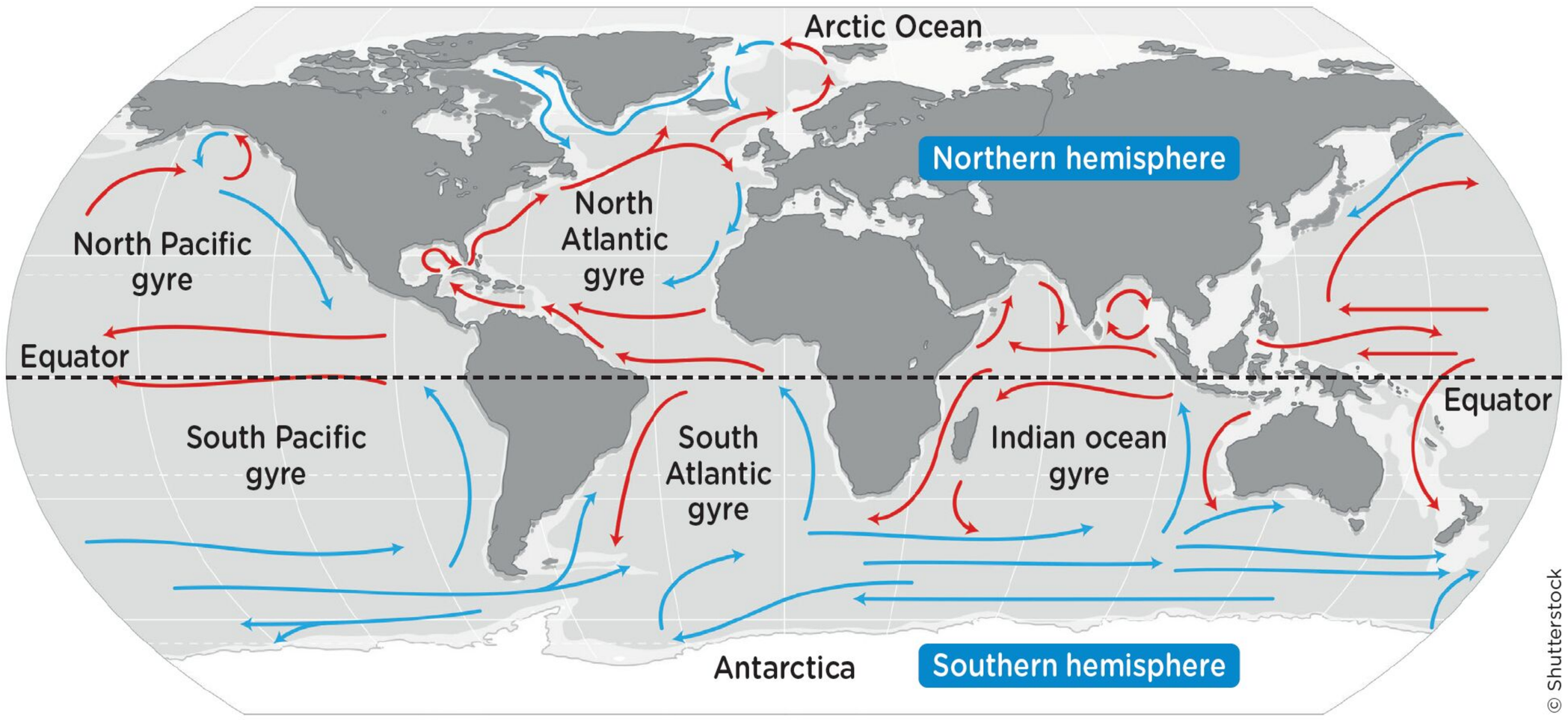
WHAT ARE CURRENTS?

Ocean currents are large masses of water that move, mainly thanks to the winds blowing on the surface of the open sea.

The currents move within the ocean taking a **very specific direction**: they tend to bend to the right in the northern hemisphere* and to the left in the southern hemisphere. That is because of the **Coriolis effect**: this phenomenon makes the winds that contribute to the currents blow diagonally from the Poles to the Equator. So, the currents turn and interconnect, forming giant water circles called **gyres**.

**The arrows indicate the direction and temperature of Earth's ocean currents: warm (red) and cold (blue).*

**Hemisphere* means "half of a sphere." Planet Earth is divided into two hemispheres—the Northern and the Southern—by the equator, an imaginary line located halfway between the North and South Poles.



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Highways of water

TRAVELING WITH THE CURRENTS!

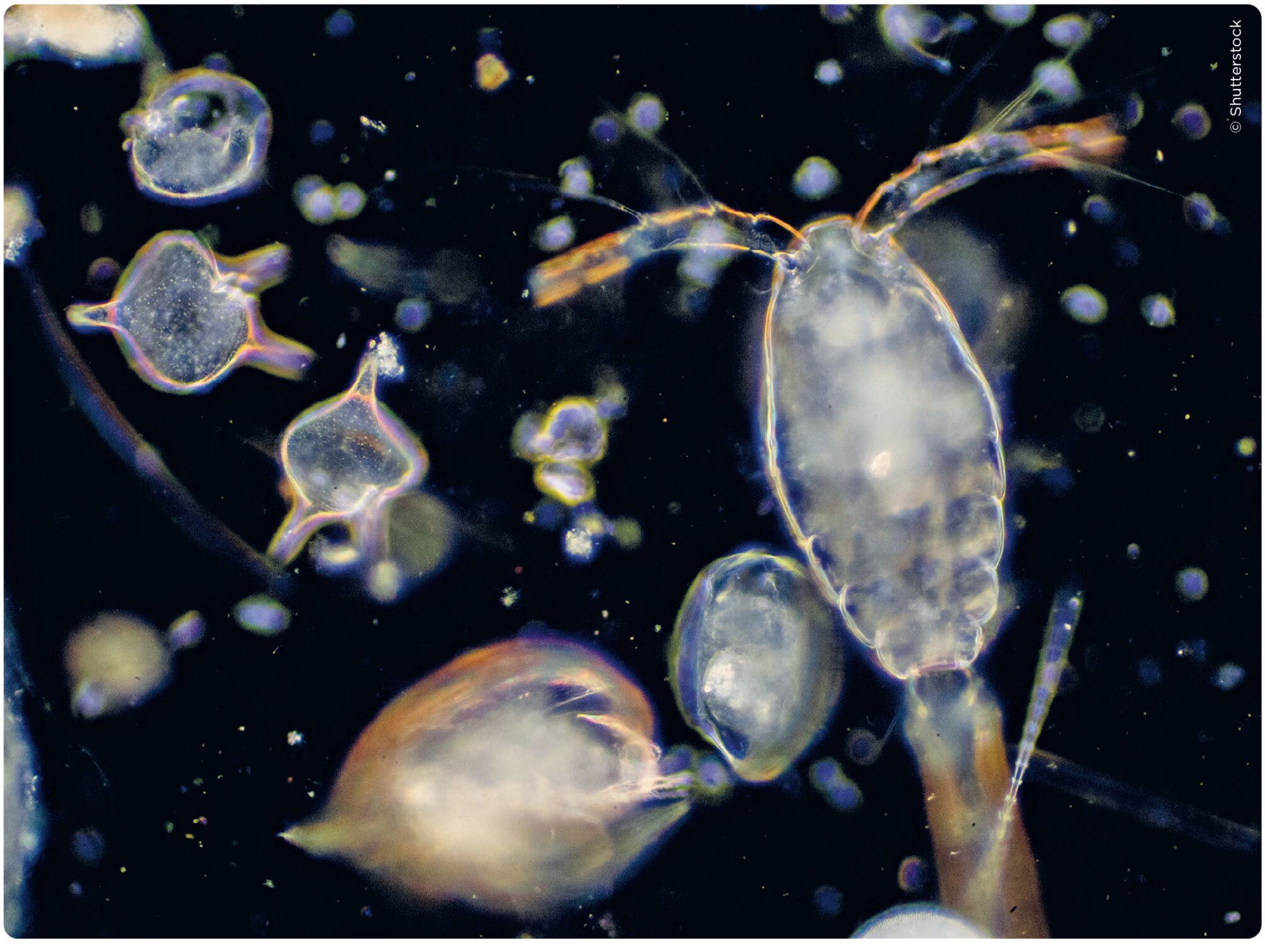
Finally, ocean currents are also a real means of transport, and many marine plants and animals actually use them **to move from one place to another**. Even skilled swimmers like whales and turtles rely on them during their migrations.

Plankton—a set of aquatic organisms such as viruses, bacteria, microscopic plants and tiny crustaceans, but also jellyfish and some big algae—also move using currents, but since they're unable to swim against them, they allow themselves to be dragged, floating in the water.

And then there are the animals that can't properly swim yet: **baby turtles**, for example, are carried by the currents until they're big enough to fend for themselves. What's more, animals and plants that live on the seabed or along the coasts also travel in this way. For example, some **terrestrial species**, such as lizards, **drift along with the currents**, using logs and coconuts as rafts!

In short, currents are really important for marine life. Thanks to them, even small islands far from land can be reached by "traveling" species.

The word *plankton* comes from the Greek and means "drifter"—a perfect name for organisms that are carried by the currents!



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SURPRISING STOPS

Are we there yet?!

Almost! Before we reach the Great Barrier Reef, I want to show you something.

Okay, do you wanna play a game?

Yeah!

What game?

Spot the blue fish! The one who spots the most blue-colored fish wins!

Now, this is what I call a **safe** game!

Found one!

What? That fish isn't blue!

It's purple! And red!

And yellow!

Um, it looked really blue to me.

But it wasn't blue!

Found one!

It's true! Dory is blue!

Can I play, too?

Sure!

Oh, I see some blue. Found one!

More blue! Found another one!

And another! Yay! I'm a champ!

That's not fair, spotting yourself!

Found--

C'mon, class! We've reached our first stop!

Let's see... who remembers the name of these big green organisms here?

No, they're macro... macro-**something**.

Seaweed!

Macroalgae!

No cheating, Marlin.

Did you know that some macroalgae are also having problems?

Really?

Is it because of **acidic water**?

Yes, exactly, but also because **water** is getting **too warm**.

Warm? What does that mean?

That it's not... cold?!

-A FEW YEARS AGO-
Water was cooler and macroalgae grew well.

In the past few years, the temperature of the ocean has gone up.

So, macroalgae **can't grow well** now.

-NOW-
Water is warmer and macroalgae find it harder to grow.

Why is the temperature rising?

We don't know exactly. But the climate is changing **everywhere**. Not just in the oceans.

What is climate?

At the Marine Life Institute, I heard them say climate is the typical weather in a place for many years and across the seasons.

Can we do something to help the macroalgae?

Well... maybe we can.

What if we move **all** the green things to a different place?

We can't, Dory! Every living organism should live in the most suitable environment for it.

What does that mean?

I'll show you. Let's take another detour... to the **beach!**

The beach?! That's too dangerous! Why not just fry the kids and serve them with chips?

I don't wanna be fried and served with... what are chips?

Nobody will fry you, Tad!

Oops! Sorry.

And after a short swim...

Whoa!

Yikes! That sand looks so **dangerous!**

No, I walked on it and it's not that bad.

Ahhh, there's so much light!

Who lives here, Mr. Ray?

Let's dive back into the water and you'll see!

Here we are. **Sandy shores** are the perfect habitat* for **bivalves*** like these, and for **sole**!

Sooooooole, where are you?

Sole? I can't see them!

Here!

Oh, dear!

*__Habitat__: The natural environment where an organism lives
*__Bivalves__: Mollusks enclosed in two shells hinged together on one side, enabling the organism to open and close

Wow! You look like the sand!

Can you blend in with the sand, too, Hank?

Of course!

That's so cool!

CLAP CLAP

Yeah, that's pretty good.

Why do sole and bivalves live here?

To take advantage of their ability to burrow in the sand to avoid crashing waves and predators!

We should learn that, too!

Look at me. ≥Pfff!≤ I can do it!

Uh... maybe that's not a good idea!

Don't worry, Marlin. Like I said, each marine organism has its own habitat. Some find **rocky shores** more suitable for them.

Like anemones!

Rock louse

Periwinkles

Limpets

Periwinkles

Limpets

Chiton

Buckshot barnacles

Sea lettuce

Hermit crab

Mussels

Chitons and limpets

Rockweed

Abalone

Acorn barnacles

Gooseneck barnacles

Seaweed

Sea urchins

Sea slug

Sea star

Sea cucumber

Brittle star

Sponge

Sea anemone

Seaweed

Exactly. Now... are you ready to continue with our trip?

I don't remember where we were going, but... **yes!**

Yeah, let's go. The Great Barrier Reef and **my vacation** are waiting!

Tee hee!

CONTINUES ON PAGE 49

DIVERSITY IS RICHNESS!

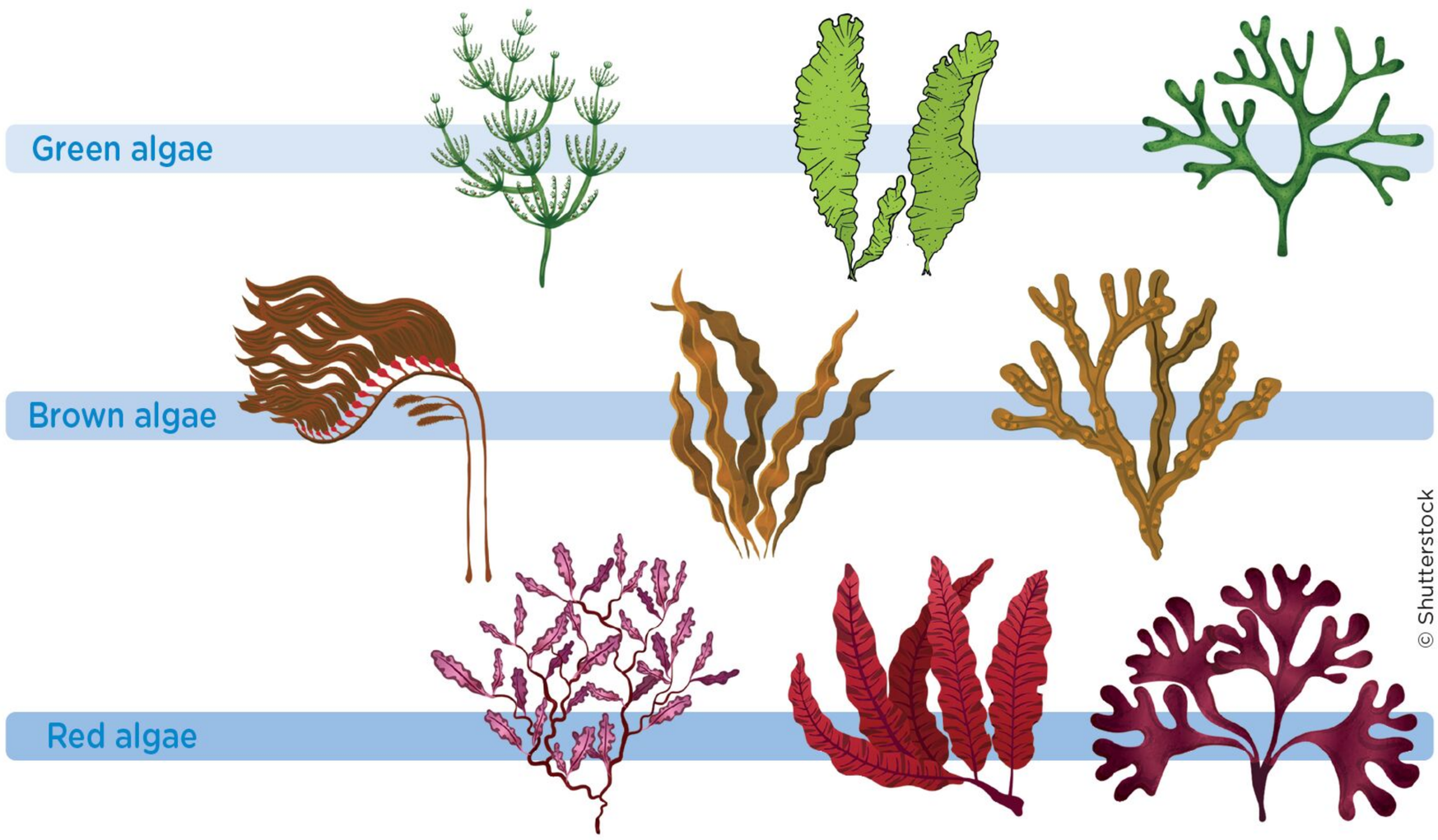
- A variety of colors
- A temperature for everyone
- The power of diversity
- An ocean to save

A variety of colors

HUNTING FOR LIGHT

The ocean is home to many **habitats**—places where different species live and grow—so different from each other that species have developed particular characteristics to adapt to living in them. Take **algae**, for example: plant organisms that feed mainly on the sugars they produce through photosynthesis. **They need light** to do this, but the ocean becomes increasingly dark in the depths. So depending on the maximum depth they can survive at, **algae have adapted with different pigments**—colored substances that can **capture light in different ways**. For example, the algae that live in the shallowest areas, where there's a lot of light, are in general green. Brown algae can also live at medium depths, while red algae can be found up to 100 meters down, where only a little light penetrates the water.

Because they need at least a small amount of light for photosynthesis, algae are found only in the photic zone, though at different depths.



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A temperature for everyone

COLD AND HEAT

Marine plants don't need just light to survive: temperature is also important. **Temperature creates different habitats, both vertically and horizontally**—vertically because the temperature decreases from the surface toward the seabed, horizontally because it varies along the Earth's surface: it is lower at the poles and higher at the equator. **Kelp**, for example, the largest of all brown algae, live in **colder waters** because these are **richer in the nutrients** they need. For this reason, kelp populate the oceans in the temperate zones and near the poles, where the water is colder, forming **kelp forests**.

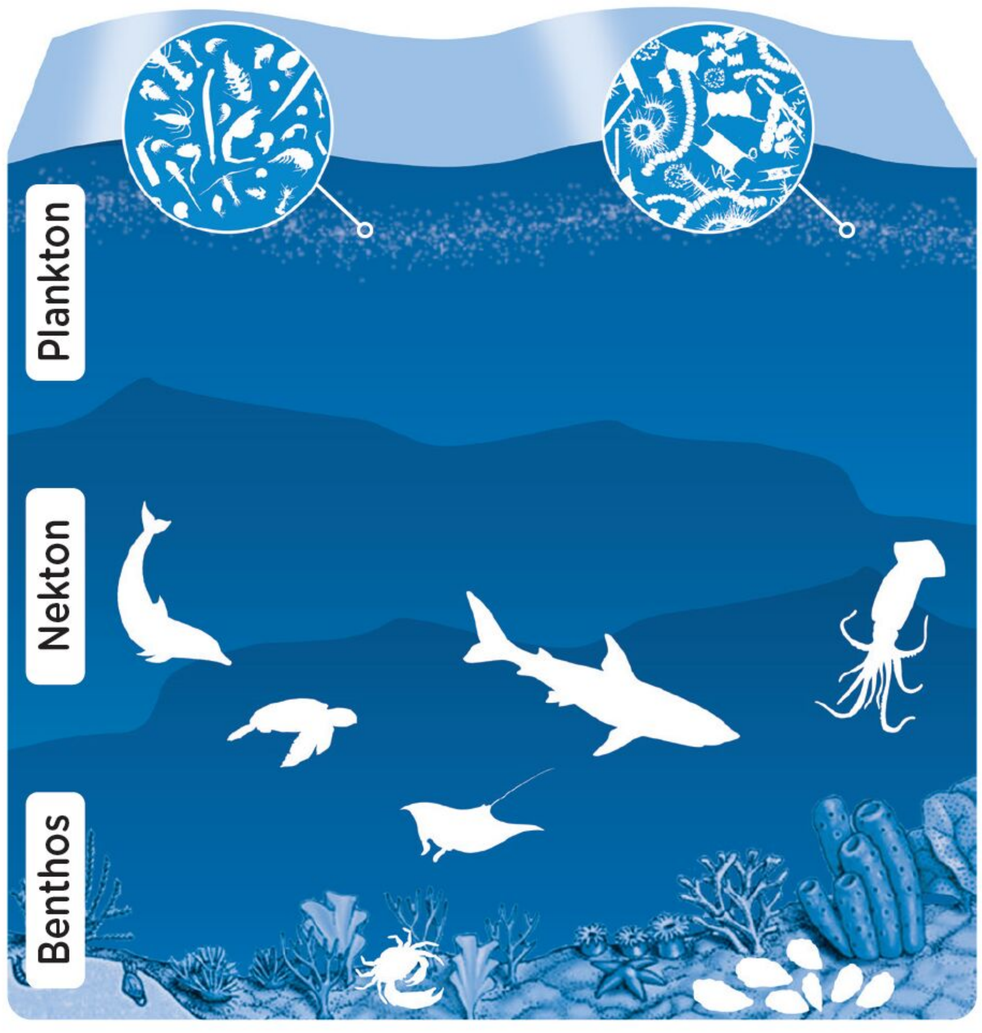
Water temperature also affects the lives of marine animals. It's been observed that, in tropical areas, waters are **less rich in nutrients**. For this reason, the competition for food is strong, and in order to survive, creatures have evolved and developed unique characteristics, enabling them to find food suited to their needs, which they don't have to "share" with other species!

A kelp forest off the coast of California, along with the fish that usually live there, including a shark and a ray.

The power of diversity

BENTHOS, NEKTON, AND PLANKTON

Marine organisms have adapted by developing different skills based on where they live in the sea. Organisms that live on the **seabed or buried** beneath it are referred to as **benthos**. On the other hand, the group of animals **that can swim** without just being dragged by the currents is called **nekton**. This includes fish but also mammals, such as dolphins, and reptiles, like turtles. **Plankton** is made up of those organisms that are too weak to swim against the currents and simply **drift along**. They can be animals, like crustaceans and jellyfish, or plants, such as some algae.

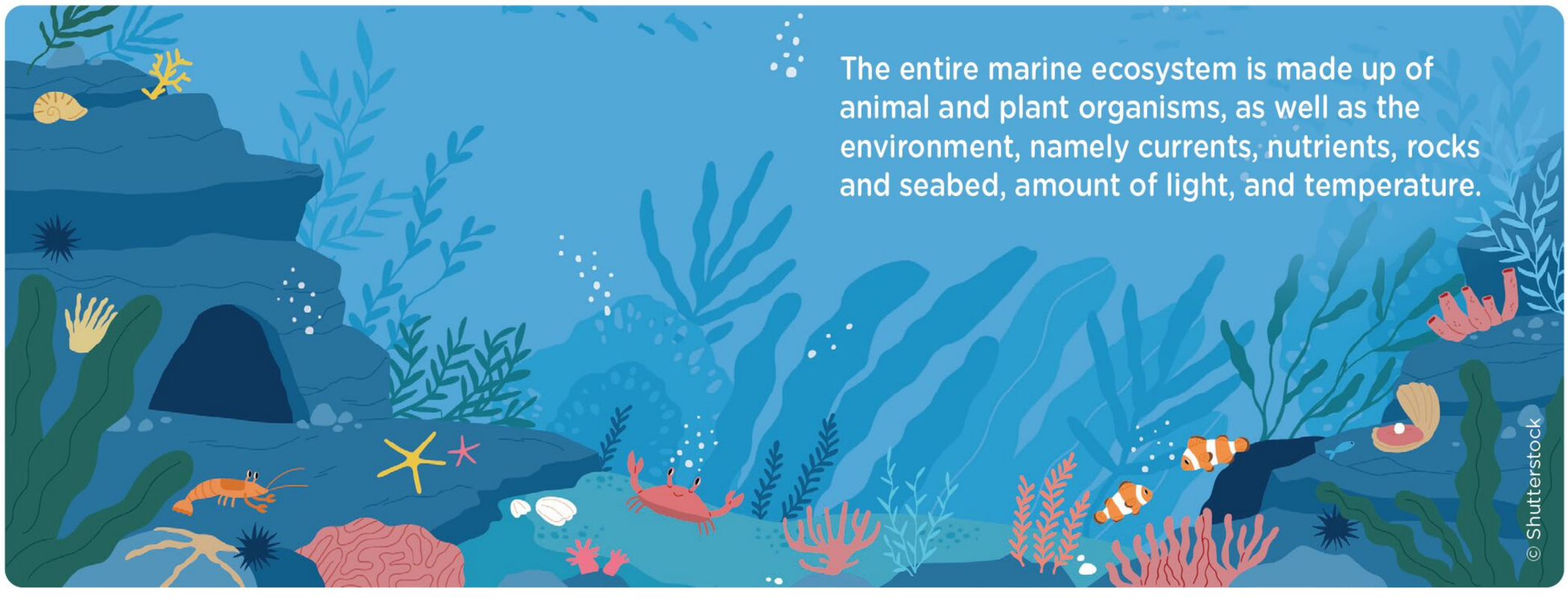


The benthos include a wide range of animals such as crustaceans, like crabs, and mollusks, like oysters.

STRENGTH IN NUMBERS

There are tens of millions of species living in the oceans. This means there's a lot of **biodiversity**, or **a large variety of organisms**. The different species of animals and plants living together in a single place form an **ecosystem**, meaning they depend on each other to survive, and—as in any team—they're all important.

The **more biodiverse** an ecosystem is, the stronger and more capable it is of withstanding natural disasters, such as a disease affecting a species or pollution caused by humans. This is why when one species is at risk, the whole ecosystem is in trouble: its biodiversity decreases!



The entire marine ecosystem is made up of animal and plant organisms, as well as the environment, namely currents, nutrients, rocks and seabed, amount of light, and temperature.

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An ocean to save

LESS AND LESS BIODIVERSITY

These days, **biodiversity is decreasing very quickly**, even in the oceans, as more and more species are becoming **extinct**—that is, disappearing. The main causes are **pollution** and humans' **exploitation of the sea**, for instance with fishing. This puts entire marine ecosystems at risk, but also life on land.

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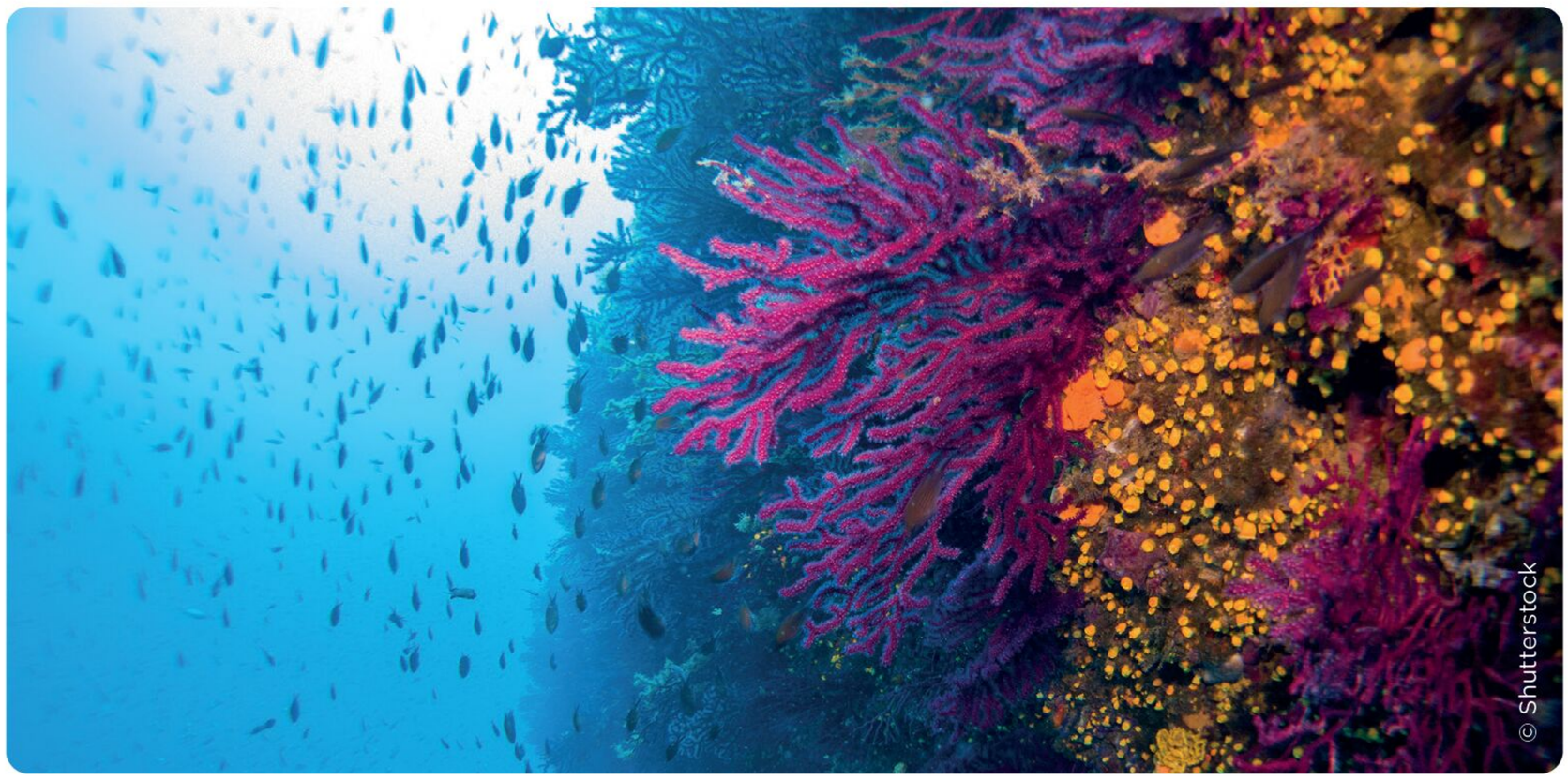
Take one example: the numerous plant organisms in the sea produce **oxygen**, which terrestrial animals breathe. As ocean biodiversity decreases, less oxygen is produced, with great danger for all animals who need oxygen to survive. This is why the biodiversity of ocean ecosystems **is vital** to the lives of everyone, including humans.

Human activities deposit many pollutants along the coasts. This is one of the main causes of the loss of biodiversity in the oceans.

SUSTAINABLE DEVELOPMENT

Protecting the sea is everyone's job: governments, scientists, and ordinary citizens. Luckily, there are already plans for managing ocean health and promoting **sustainable development**. This means making sure that human actions in the world, such as building cities or industries, are environmentally friendly so that they pollute less and don't waste natural resources. But this is just the first step in protecting the oceans. Another way of doing so is by increasing **marine protected areas**, clean areas of the sea where marine organisms can live without being disturbed or harmed.

Red gorgonian growing in the marine protected area close to Portofino (Italy). Here, humans can't carry out certain activities, such as fishing, in order to preserve biodiversity.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A COLORLESS PROBLEM

CRAAAASH

Oh, dear! We should go back home!

What's happening?

Don't worry, class! It's just a thunderstorm on the surface!

A thunderstorm? Wow!

Don't worry, Marlin! We're safe here!

Um, okay. Maybe we are.

WHOOOSH

Hold on tight, class! Sea currents incoming!

WHOAAA!

This is getting too dangerous... ff-f-for the kids!

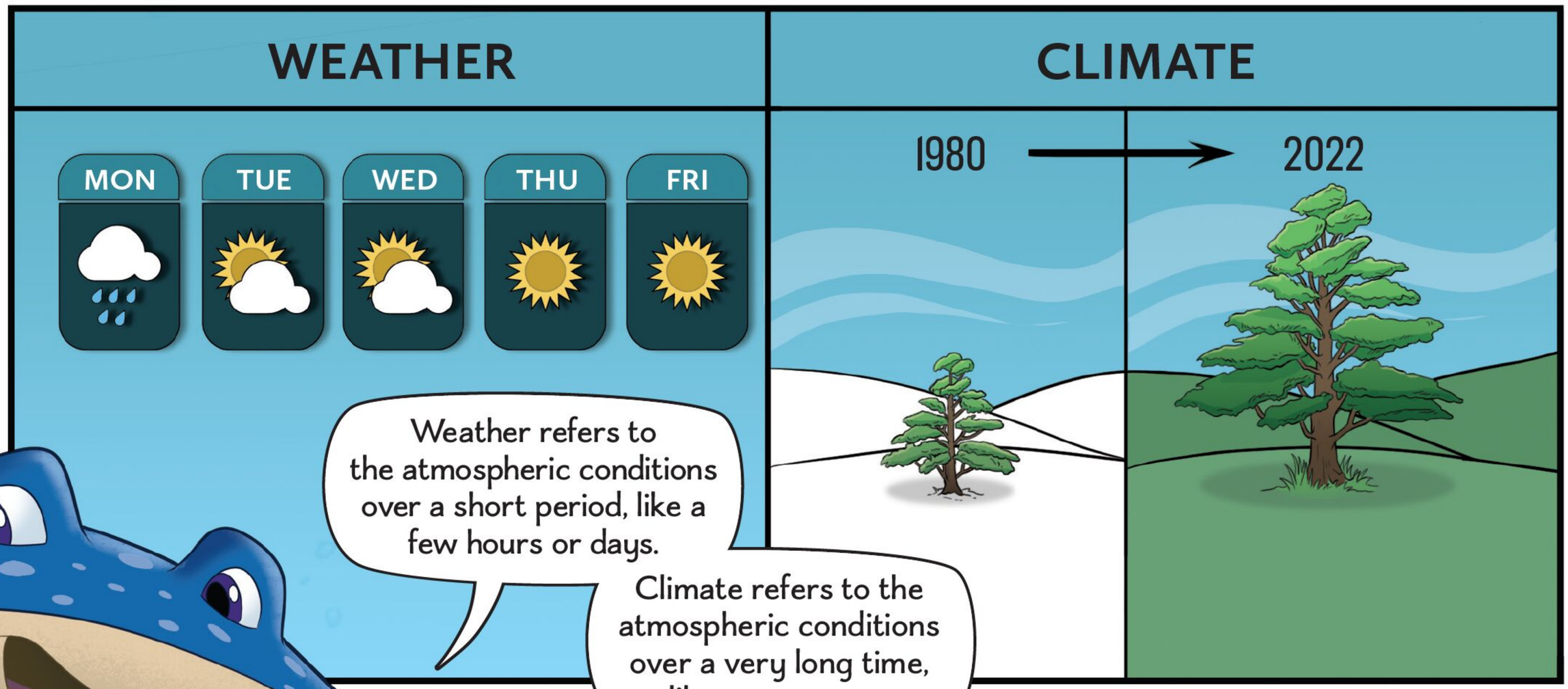
Take it easy, Marlin. These are just **currents** caused by the storm.

I know, but... it's not safe to go on a trip in this **weather**!

Mr. Ray, are weather and climate the same thing?

Yeah, what's the difference?

These are such complex questions, explorers. Let's dig into it! The difference depends on **time**.

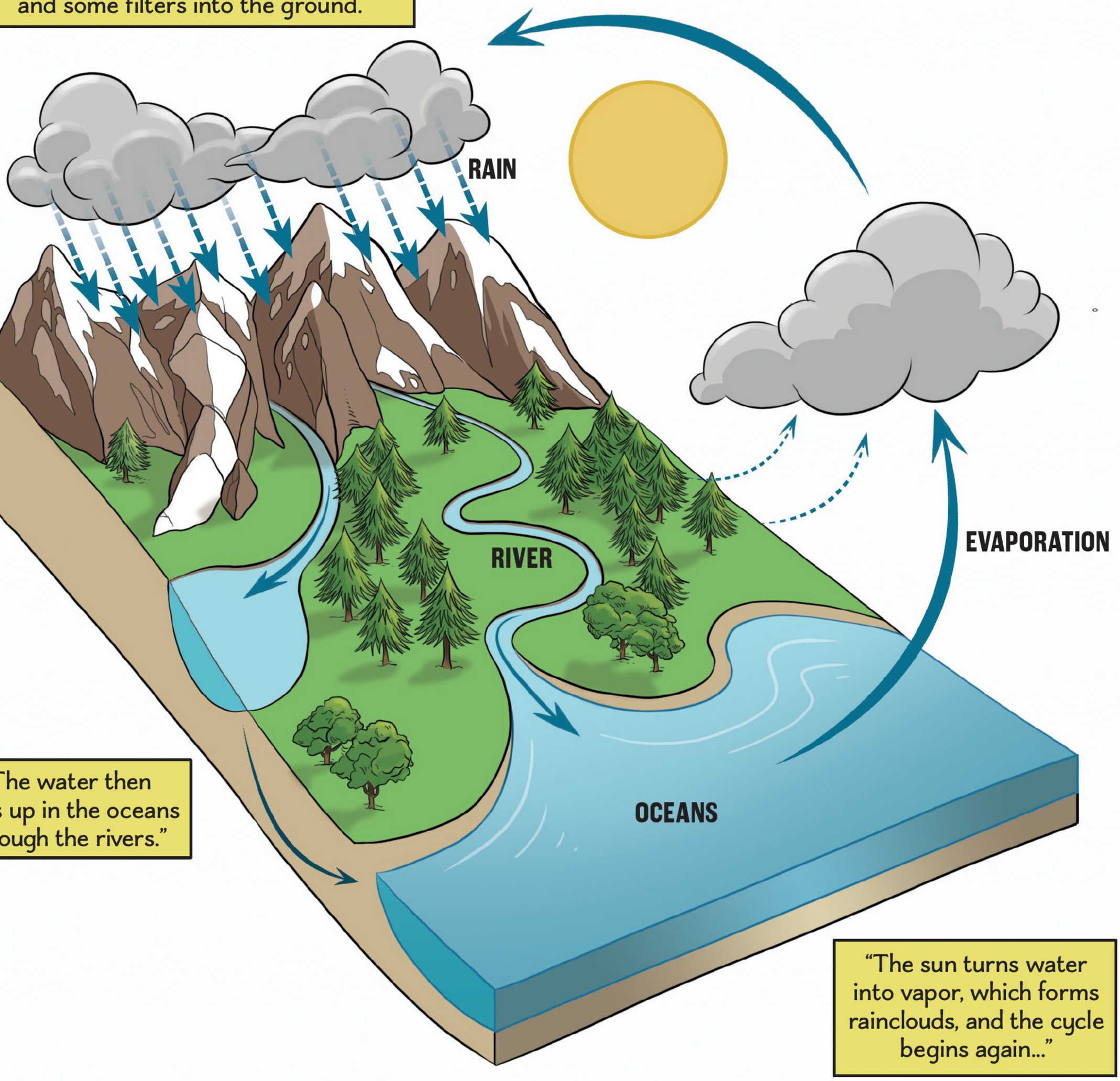


Can we see the rain in the deep waters?

Is the rain... water?

Yes, and even though we who live in the oceans can't experience it directly, rain is more connected to the ocean water than you think.

"When rain falls from raincloud, some water collects in ponds, lakes, and rivers, and some filters into the ground."



"The water then ends up in the oceans through the rivers."

"The sun turns water into vapor, which forms raincloud, and the cycle begins again..."

At the Marine Life Institute, I remember hearing that climate affects the weather.

Yes, and as we just saw, weather affects the **sea currents**.

What?!

When it rains on the surface, we notice the sea currents changing.

Oh, now I understand!

And we can also see this **debris**, coming from the rivers.

Stay back! Don't touch it!

When it rains, the rivers become full and bring a lot of fresh water into the sea, along with lots of materials coming from inland!

Whoa, I didn't know that!

That's scary!

Yeah, maybe we should go to the Great Barrier Reef now!

You're right! We should go right now!

Hey, let's play another game! Can you swim upside down?

Um...

Let's go, explorers!

SWOOSH

Finally...

Here we are! Welcome to the Great Barrier Reef!

HOORAY!

At last! I thought we'd never reach this place!

Okay, now I've got a game for you, class!

Yay!

Wow!

What game?

I don't know, I'm just waiting to get to my vacation.

The most important thing is that they're safe!

Now I want you to take a closer look at the corals and tell me one thing you notice!

I'm ready!

I'll notice **one hundred** things!

This is so exciting!

Let's play, too!

They look like **flowers!**

They look just like the suction cups on my tentacles.

They're called **polyps.**

Yes, they're **living creatures!**

Every fish knows that!

Looks like they can be **soft** or **hard!**

The corals are beau-- Are they losing their colors?!

What's happening to them, Mr. Ray?

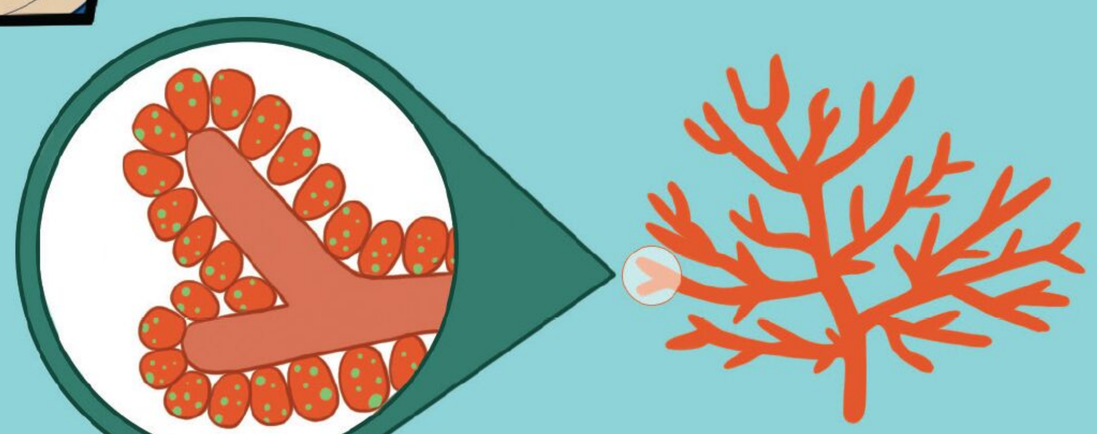
Oh, no! They've turned **white**!

I didn't know it was happening here, too. You see... coral needs special **microalgae** to survive.

The microalgae live inside the corals and make food for them through photosynthesis.

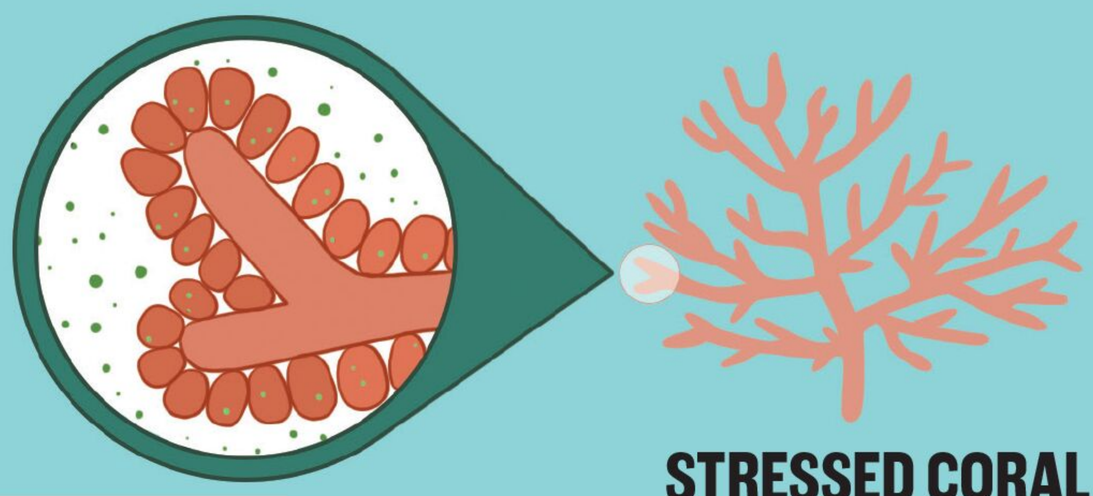
"When algae live inside them, corals are healthy and colorful."

"But when the water gets too warm, the algae become stressed and produce substances that damage the corals."



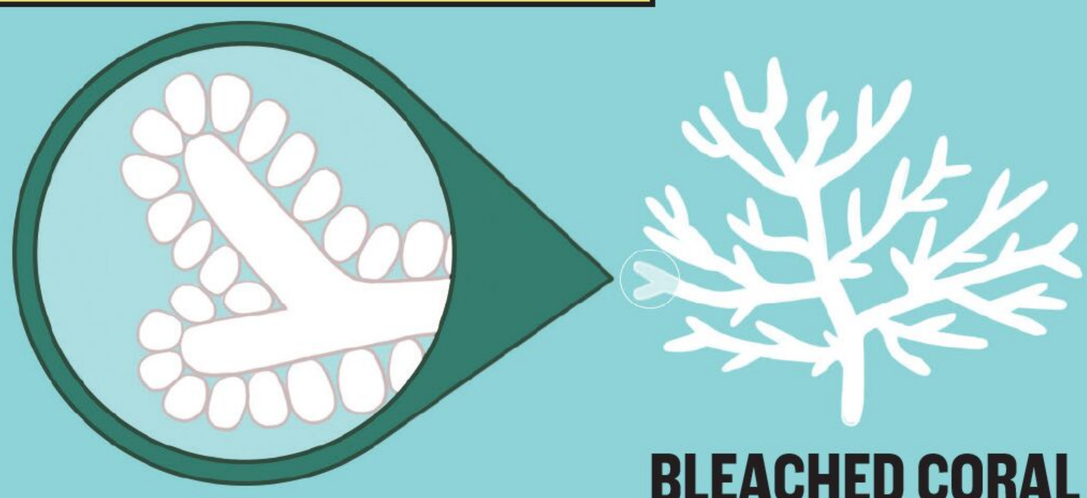
HEALTHY CORAL

"So the corals react by spitting out the algae."



STRESSED CORAL

"Without them, the corals' tissue becomes transparent, revealing their **white skeletons**. This is called **coral bleaching**."



BLEACHED CORAL

"Bleached corals are unhealthy and at risk of dying."

Why are these corals stressed?

Don't they like living here on the reef?

They do, Tad, but the water is getting too warm for them!

Warm water wasn't good for the macroalgae we saw earlier, either!

That's right, Sheldon!

It's strange, but... I remember that, too!

Can we do something to help them, Mr. Ray?

I don't think so, Nemo.

The macroalgae, the thinning shells, and now the corals. It looks like everyone's in trouble! What if our home disappears?

Well, some of these corals are still okay, but I'm not sure what to do. We need to head back now.

The other parents have arrived to pick up their kids, and...

Thank you, Mr. Ray!

Good night!

Bye, everyone!

Now what? We need to help the corals.

Oh! I just remembered seeing something about coral bleaching back at the MLI ...

Really?

Yeah, maybe we could go there together to look for some answers. I can go on vacation another time.

That's a great idea! We might find a way to help the shells and macroalgae, too.

Yeees!

This will be a long journey. So let's get some rest now and leave tomorrow at dawn.

Yes! We're gonna save the ocean!

Oh, dear. This is gonna be a risky mission.

CONTINUES ON PAGE 63

Ocean acidification

TOO-ACIDIC WATERS

The increase in carbon dioxide in the air directly modifies the ocean: it **acidifies it**. Part of the carbon dioxide present in the air is naturally absorbed by ocean waters and transformed into one particular substance: **carbonic acid**. This means that the more carbon dioxide there is in the air, the more there is in the sea, too, making the water more acidic. The acidity of the water can be measured with the **pH** scale: **the lower the pH number, the more acidic the substance**. And in recent years, the ocean's pH has gone down: this is called **ocean acidification**.

The pH scale goes from 0 to 14, from acidic to its opposite, alkaline. The central value, 7, indicates a neutral pH, neither acidic nor alkaline.

DELICATE BALANCE

- **Ocean acidification**
- **A threat to the sea**
- **The world of corals**
- **Look out for changes**

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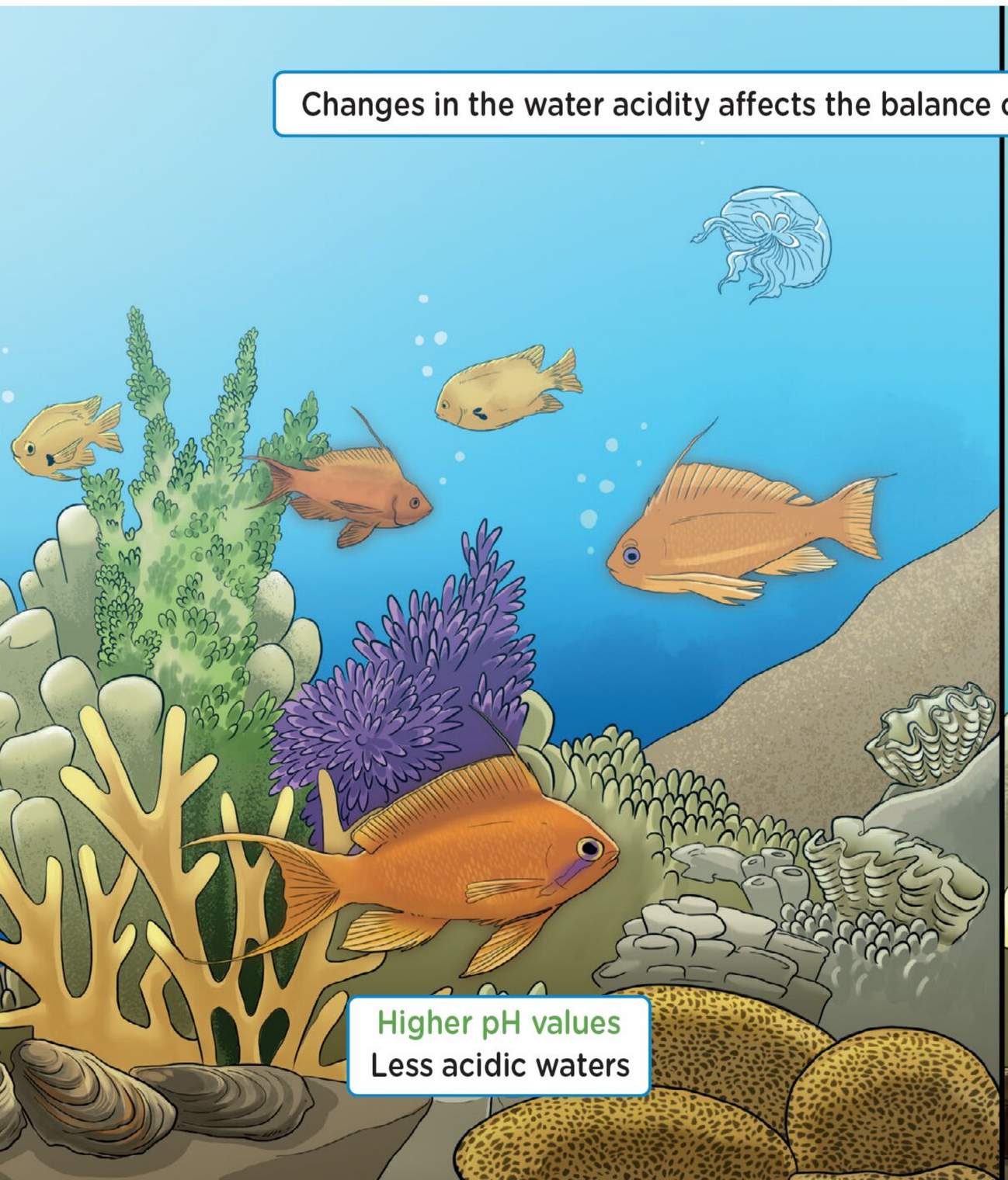
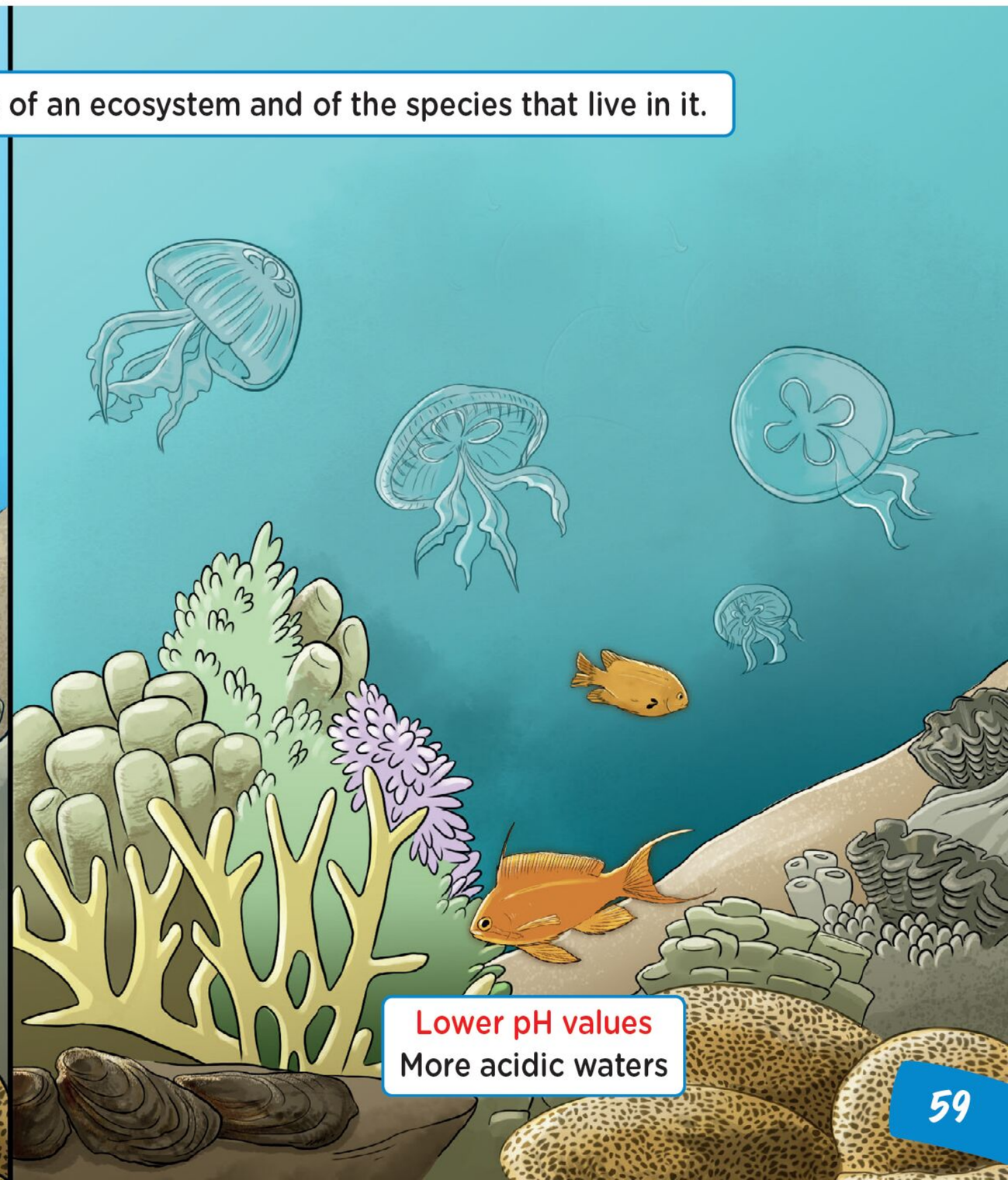
Changes in the water acidity affects the balance of an ecosystem and of the species that live in it.





A threat to the sea

SHELLS AT RISK!

Organisms with shells are particularly threatened by ocean acidification. Shells contain large quantities of a hard salt called **calcium carbonate**, which makes them quite strong and thick. But when the pH of the water is lower, the formation of calcium carbonate shells slows down. And it can even be blocked because **acidification modifies the chemical reactions** needed to form calcium carbonate. Because of that, the shells are often thinner, so they're less effective in protecting the animals that live inside them.

So due to the acidification of the water, organisms with shells need more time and **more energy** to produce their protective shelters.

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This marine mollusk shell has been damaged and corroded by the water's acidity.

ANIMALS IN DANGER

Acidification endangers the lives of many creatures. For example, squids' eggs develop later and with more difficulty in acidic waters, though the causes are still unclear.

What's more, ocean acidification could also **affect the equilibrium of marine ecosystems**. For example, the numbers of animals with shells, like barnacles and mussels, falls because they are damaged by lower pH. On the other hand, creatures without shells can survive, but they increase too much in number. This changes the balance of species in an ecosystem, often damaging it.

The world of corals

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PLANTS OR ANIMALS?

Coral reefs, the areas of the oceans that are richest in life, are also made up of enormous quantities of calcium carbonate, which is deposited by some of the organisms that live there. Coral reefs are home to thousands of species, but only some of them deposit calcium carbonate: the most important ones are corals. But are corals plants or . . . animals? Both! The **corals** are animals, **little polyps**, which contain microalgae: **zooxanthellae**. Thanks to photosynthesis, the zooxanthellae feed the coral that hosts them and create a chemical equilibrium, making calcium carbonate. It's mostly thanks to these microalgae and the pigments they contain that coral has such wonderful colors.

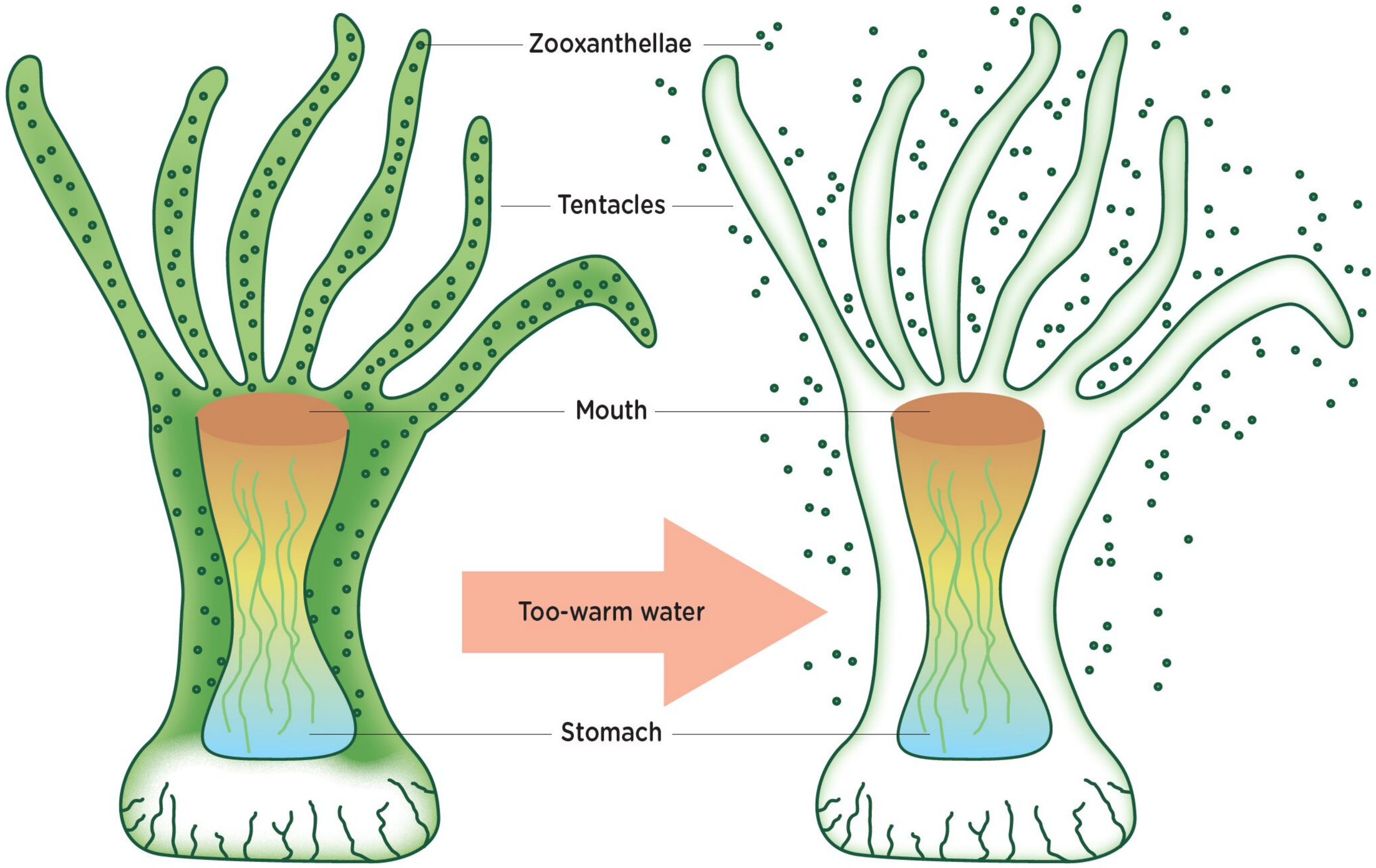
Because the zooxanthellae need light for photosynthesis, coral reefs grow only in **shallow, warm and clear waters** that the sun's rays can reach, such as on **continental shelves**, the part of the continent that extends into the sea and ends up submerged by the waters. Or around islands and on the tops of underwater mountains, known as **seamounts**. In short, coral reefs are found in the warmest, shallowest areas of the oceans, where the water temperature is over 20°C.

Thousands of plant and animal species find food and shelter in coral reefs, including fish, crustaceans, and mollusks.

Look out for changes

CORALS IN DANGER

In recent decades, coral reefs have been endangered by various threats, including **pollution** and **overfishing**, but above all by **climate change**, which causes the ocean temperatures to become too high. This is dangerous because water that's too warm becomes harmful to corals. **Bleaching**—when the amazing colors of the corals start to fade away—is often the first clue that something is wrong. When the water temperature is too high, the zooxanthellae suffer and produce chemicals that damage the coral. The **coral then defends itself by spitting out the zooxanthellae**, which contain colored pigments. Without them, the coral appears white.

In general, the coral doesn't immediately lose all its zooxanthellae: some remain and grow back. Or it can happen that the coral manages to get new ones from the surrounding water. So the coral recovers its colors and its extraordinary beauty. But if the temperature of the ocean rises too much, and for too long, the coral can **no longer** recover its zooxanthellae or receive the nourishment they provide. Unfortunately, this means that it dies in the end. That's why it's important to keep **global warming**— the overall increase of temperature on Earth which has progressed too quickly in the past 100 years—under control.

Corals consist of small polyps with a mouth, stomach, and tentacles. When the water is too warm, the polyps expel the zooxanthellae and turn white.